INQUIRY TRAINING MODEL OF TEACHING

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PREFACE

The practice of training programme in teacher education is generally arranged on Herbartian Methods of teaching and the trainees are generally trained through the Wholistic Approach.

In 1972, a group of researchers started experimenting with a new approach of training for the teachers. This approach, namely, Micro-teaching, emerged as one of the major innovations of the country. It has transformed the student teacher training programme in some institutions. A number of research studies were organised to see the effectiveness and adaptability of microteaching. However, the question of integration of skills was a crucial bottle-against the speedy neck development of new Models of Teaching. In this process the work of Bruce Joyce and Weil Marsha has proved immensely useful. Accordingly, the journey from Microteaching to Models of Teaching took a new shape as a result of the efforts of NCERT and Devi Ahilya Vishwavidyalaya, Indore.

A large number of orientation and research seminars have been conducted on Models of Teaching in different parts of the country. Need for adequate instructional material has been felt for the effective use of these models. In the massive teacher education programme of the New Education Policy, the Inquiry Training Model has been identified as an important component. Keeping these points in mind, a group of researchers viz., B. K. Passi, L. C. Singh, D. N. Sansanwal, C. G. D'Lima, S. P. Malhotra, D. R. Goel, Clifton Lobo, Sugandhi R. Prabhu and Jessi Martis have made a joint effort to prepare the present, module This team of researchers has made rich contributions by synthesising the findings of various research studies and the practical experience gained at various seminars and workshops on models of teaching.

Dr C. G. D'Lima, and Dr. S. P. Malhotra, the dynamic researchers and resource personnel in models of teaching have contributed their unique potential in bringing out this modee. Dr. A. N. Joshi has been a source of inspiration for this work.

The texts of information processing models written by Weil Marsha and Bruce Joyce have been of immense use. We acknowledge their support and help. This material has been produced due to the inspiring and motivating support of Bruce Joyce and Professor Showers who visited Indore in 1984.

We thank Dr. Mahesh Bhargava, Director, National Psychological Corporation who has published this model in a way short period.

12th Feb, 1987

B. K. Passi
L. C. Singh
D. N. Sansanwal

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Introduction To Models Of Teaching

B. K. PASSI
L. C. SINGH
D. N. SANSANWAL

INTRODUCTION

Experts in the field of education, all over the world, are seriously thinking of a variety of approaches to teaching to achieve different instructional objectives. Experience has shown that there is no one particular way which can be said to be the approach to achieve any instructional objective. Therefore, we may require a number of ways to create the right environment for learning. Further we need to do research and find out which is the best one to achieve a particular goal.

To provide all round development, we need to design suitable instructional strategies which help our students to grow emotionally, physically, socially, and intellectually. We need to know how to modify their behaviour so that they function effectively in a changing society. To carry out these multiple responsiblities the teachers are required to engage in several professional roles. To prepare the teachers for a variety of roles Bruce Joyce and Marsha Weil have searched and researched on a variety of strategies developed by different learning theorists and designed a number of models of teaching.

MODELS OF TEACHING

A Model of Teaching consists of guidelines for designing educational activities and environments. The Models of Teaching are meant for creating environments. They provide specifications for constructing learning situations. Model of Teaching is a

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[1] This chapter draws heavily from Models of Teaching by Bruce Joyce and Marsha Weil published by Prentice Hall (with permission from the authors).

plan that can also be utilized to shape courses of studies, to design instructional material and to guide instruction.

The Models of Teaching are developed by people who worked in different fields. They are based on empirical work, theories and researches. Some of the persons whose theories and researches have contributed to the development of different models are :

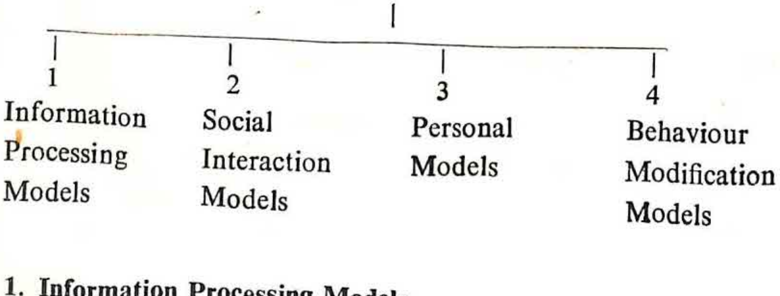
—Counsellors and Therapists—Erikson, Maslow, and Rogers.
—Learning Theorist—Asubel, Bruner and Skinner.
—Development Psychologist—Hunt, Kohlberg and Piaget.
—Philosphers—Broudy, Dewey and James.

Bruce Joyce and other developed ways of making the theories operational. Thus, each model has a rationale that justifies it and describes what is good and why. Thus, these models link different skills to teaching to theory.

FAMILIES OF MODELS

Bruce Joyce and Marsha Weil have developed more than twenty models which are grouped on the basis of their chief emphasis—the way they approach educational goals and means. They have organized these models into the following four families.

FAMILIES OF MODELS


1
Information Processing Models
2
Social Interaction Models
3
Personal Models
4
Behaviour Modification Models

1. Information Processing Models

Information Processing Models share an orientation towards the information processing capability of students and ways they can improve their ability to master information.

Information processing refers to the way people handle stimuli from the environment, organize data, sense problems, generate concepts and solutions to problems, and employ verbal and nonverbal symbols.

Some information processing models are concerned with the ability of the learner to solve problems and thus emphasize productive thinking ; others are concerned with general intellectual ability. A large number emphasize concepts and information derived from the academic disciplines. Some of the models classified under this family are given in Table 1.

2. Social Interaction Models

These models emphasize the relationships of the individual to society and to other persons. They focus on the process by which reality is socially negotiated. Consequently, with respect to goals, models from this orientation give priority to the improvement of the individual's ability to relate to others, to engage in democratic processes, and work productively in the society Table 2 gives the list of models belonging to this family.

3. Personal Models

These models share an orientation towards the individual and the development of selfhood. The models emphasize the processes by which individuals construct and organize their unique reality. Frequently, they focus on the emotional life of the individual.

It is expected that the focus on helping individuals to develop a productive relationship which the environment and to view themselves as capable persons will produce richer interpersonal relations. Table 3 enlists some of the models belonging to this family.

TABLE 1 : INFORMATION—PROCESSING MODELS

Model	*Major Theorist*	*Missions or Goals for which intended*
Inductive Thinking Inquiry	Hilda Taba, Richard Suchman	Designed primarily for development in inductive mental processes and academic reasoning of theory building, but these capacities are useful for personal and social goals as well.
Scientific Inquiry	Joseph J Schwab (also much of the Curriculum Reform movement of the 1960's)	Designed to teach the research system of a discipline, but also expected to have effects in other domains (sociological methods may be taught in order to social problem solving).
Concept Attainment	Jerome Bruner	Designed primarily to develop inductive reasoning but also for concept development analysis.
Cognitive Growth	Jean Piaget, Irving Sigel, Edmund Sullivan	Designed to increase general intellectual development especially logical reasoning, but can be applied to social and moral development as well (See Kohlberg 1966).
Advance Organizer Model	David Ausubel	Designed to increase efficiency of information processing capacities to meaningfully absorb and and relate bodies of knowledge.
Memory	Jerry Lucas	Designed to increase capacity to memorize.

TABLE 2 : SOCIAL—INTERACTION MODELS

Model	*Major Theorist*	*Missions or Goals for which intended*
Group Investigation	Herbert Thelen John Dewey	Development of skills for participation in democratic social process through combined emphasis on interpersonal (group) skills and academic inquiry skills. Aspects of personal development are important outgrowth of this model.
Social Inquiry	Byron Massialas Benjamin Cox	Social problem solving primarily through academic inquiry and logical reasoning.
Laboratory Method	National Training Laboratory (NTL)	Development of interpersonal and group skills and through this, personal awareness and flexibility.
Jurisprudential	Donald Olive James P. Shaver	Designed primarily to teach the jurisprudential frame of reference as a way of thinking about and resolving social issues.
Role Playing	Famine Shafted George shafted	Designed to induce students to inquire into personal and social values, with their own behaviour and values becoming the source of their inquiry.
Social Simulation	Sarene Boocock	Designed to help students experience various social processes and realities and to examine their own reactions to them.

TABLE 3 : PERSONAL MODELS

Model	*Major Theorist*	*Mission or Goals for which intended*
Non directive Teaching	Carl Rogers	Emphasis on building the capacity for personal development in terms of self awareness, understanding, autonomy and self-concept.
Awareness	Fritz Perls William Schutz	Increasing one's capacity for self-exploration and Self-awareness. Much emphasis on development of interpersonal awareness and understanding, as well as body and sensory awareness.
Synectics	William Gordon	Personal development of creativity and creative problem-solving.
Conceptual Systems	David Hunt	Designed to increase personal complexity and flexibility.
Classroom Meeting (Social Problem Solving)	William Glasser	Development of Self-understanding and responsibility to oneself and one's social group.

4. Behavioural Modification Models

These models have evolved from attempts to develop efficient systems for sequencing learning tasks and shaping behaviour by manipulating reinforcement. Exponents of reinforcement theory, such as Skinner (1957) have developed these models and operant conditioning as their central mechanism. They are frequently referred to as behaviour modification theorists because they emphasize changing external behaviour of the learners and describe them in terms of visible behaviour rather than underlying behaviour. Table 4 enlists some of the models belonging to this family.

Operant Conditioning has been applied to a wide variety of goals in education and other areas, ranging from military training to the improvement of interpersonal behaviour and even to therapy. It is represented by a large number of models. Some of which are media-oriented (such as programmed strategies) and some of which are oriented to interactive teaching (such as those of tokens to shape social behaviour).

These families of models are by no means mutually exclusive. The actual prescription for developing the instructional activities and learning environments that emerge from some of them—even those classified in different families—are remarkably similar. For example nearly all models from Information Processing category are also concerned with social relationships and the development of an integrated functioning self. Whereas in the case of Social Interaction Models, while social relation is emphasized more than other domains, it is also concerned with the development of the mind and the self, and the learning of academic subjects. Also within the families, models share many features with respect both to goals and to the kinds of means they recommend.

MAKING THEORIES PRACTICAL

Each model consists of theory and practical training. To translate a theory into practical teaching form, a set of four con-

TABLE 4 : BEHAVIOUR MODIFICATION/CYBERNETIC MODELS

Model	*Major Theorist*	*Mission or Goals for which intended*
Programmed Instruction	B. F. Skinner	Facts, concepts, skills.
Managing Behaviour	B. F. Skinner	Social behaviour/skills.
Relaxation	Rinn, Wolpe	Personal goals (for example, reduction of stress, anxiety).
Anxiety Reduction	Rinn, Wolpe	Substitution of relaxation for anxiety in social situations.
Assertive Training	Wolpe	Expression of feeling in social situation.
Simulation	Link, Guestzkow Glasser	Concepts and decision making skills.
Direct Training	Lumsdaine	Pattern of behaviour skills.

cepts : syntax, principles of reaction, social system, and support system are employed.

Syntax

Syntax describes the model as a flow of actions. It is described in terms of sequences of events, which are called phases. Each model has a distinct flow of phases.

Principles of Reaction

Principles of reaction guide the teacher's response to the learner ; they tell the teacher how to regard the learner and respond to what he or she does. In some models, the teacher overtly tries to shape the behaviour by rewarding certain student activities and maintaining a neutral stance toward others. In other models, such as those designed to develop creativity, the teacher tries to maintain a nonevaluative, carefully equal stance so that the learners become self directing. Principles of reaction provide the teacher with rules of thumb by which to "tune in" to the student and select appropriate response to what the student does.

Social System

Social System provides a description of student and teacher roles and relationships and the kinds of norms that are encouraged. The leadership roles of the teacher vary greatly from model to model. In some models, the teacher is a reflector or a facilitator of group activity ; in others, a counsellor of individuals ; and in still others, a taskmaster. In some models, the teacher is the centre of activity and the source of input, the organizer and pacer of the situation. Some models provide for relatively equal distribution of activity between teacher and student, whereas others place the student at the centre.

Support System

Support System refers to additional requirements beyond the usual human skills, capacities, and technical facilities necessary to implement a model. For example, a human relations model may require a trained leader ; a nondirective model may require a particular type of personality. A classroom supplied only with textbooks would be limiting and prescriptive ; additional support in the form of books, films, self-instructional systems, travel arrangements and the like is necessary. Support requirements are derived from two sources : the role specifications for the teacher and the substantive demands of the experience.

INSTRUCTIONAL AND NURTURANT EFFECTS

The effects of an environment can be direct designed to come from the content and skills on which the activities are based. Or, effects can be implicit in the learning environment. The description of the effects of model are categorized as the direct or instructional effects and the indirect or nurturant effects. The instructional effects are those directly achieved by leading the learner in certain directions. The nurturant effects come from experiencing the environment created by the model.

In choosing a model for teaching, curriculum building, or as a basis for materials, the teacher must balance instructional efficiency, or directness, and with the predictable nurturant effects as shown in the figure 1

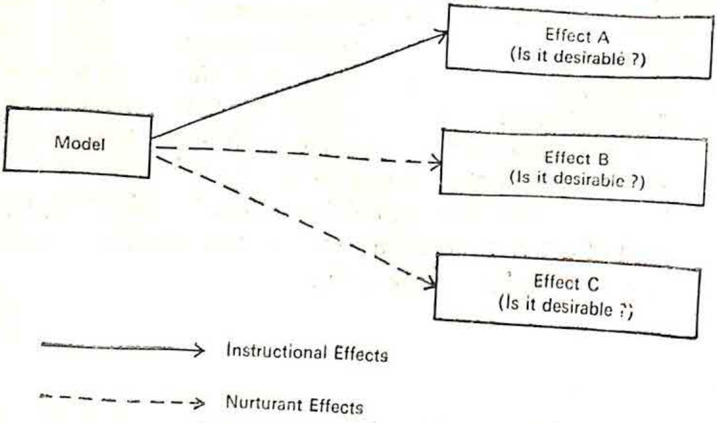


Fig 1.

SELECTION OF MODEL

Out of the four families it was felt that we should select one model from the Information Processing Models for the simple reason that our education system is more oriented to acquiring information. Hence, it was thought that if we can provide better approaches in information processing, it would improve the information processing capability.

Theoretically speaking it is desirable to train the teachers in all the models. Although it is claimed by Joyce and Weil (1978) that the time needed to learn new models of teaching shortens with each new acquisition. As a priority, it was thought advisable to train the teachers in one model at this early stage especially when not much research is done in India.

We decided to select Suchman's Inquiry Training Model. This model was selected because : (i) easy to handle, (ii) wide applicability across subjects, and (iii) acceptability by the teacher-educator community due to their inductive nature. Also critical thinking abilities could be developed through this model.

2

Inquiry Training Model A Theoretical Framework

D. N. SANSANWAL
S. P. MALHOTRA

INTRODUCTION

Generally, it has been observed that children ask many questions about the things they see and hear around them. They ask questions primarily to collect information about their surroundings. This habit is not only confined to the childhood stage but continues throughout life. In adulthood the questions are related to problem solving. These very same questions have a great potential value to solve problems if they are logically sequenced. It stands to reasons, therefore, that we need to train individuals to develop the habit of asking logically sequenced questions. Richard Suchman (1957) has developed a Model of Teaching so as to bring in the critical inquiry thought in an orderly process. The model developed by him is known as Inquiry Training Model.

Suchman's Inquiry Training Model is classified under the Information Processing Models of Teaching (Joyce and Weil, 1985). The Information Processing Models refer to ways by which people handle stimuli from the environment, sense problems, organize data, generate concepts and solutions to problems. They are also concerned with social relationship and development of an integrated functioning self. In other words, the information Processing Models share an orientation towards the information processing capabilities of students and towards the system that can improve their information processing capabilities.

ASSUMPTIONS UNDERLYING INQUIRY TRAINING MODEL

The Inquiry Training Model is based on the following assumptions ;

1. **All knowledge is tentative :** Scholars constantly generate theories and explanations. These are replaced by new theories and explanations. For example, famous theories like, Darwinism, Freudianism, Marxism, etc. have changed a lot in the course of time. This reflects that all knowledge is tentative.

2. **There cannot be one answer to a particular cause and effect question :** Whenever a cause-effect question is viewed from different angles it is likely to give different explanations. For example, blood pressure (effect) in the human body may arise because of different reasons (causes).

3. **Human beings are curious and problem solvers by nature :** Individuals when faced with a puzzling situation are motivated to explore the data surrounding the discrepant event. They put these data together in new ways to find answers to the problem.

4. **Team approach is better than the individual approach to find solutions to a problem :** Each Individual member of a team thinks in his own way and this leads to diversity of ideas related possible solutions to the problem. It also facilitates the development of knowledge.

5. **The process of inquiry can be taught to students :** The students can be introduced to the language and operations of inquiry process. This includes asking pin-pointed questions, and thinking in reflective manner. All these abilities can be developed by making students participate through the process of inquiry.

OBJECTIVES OF INQUIRY TRAINING MODEL

The Inquiry Training Model helps in the attainment of the following main objectives :

1. **To develop Scientific process skills**—*observing, collecting and organizing data, identifying and controlling variable,*

formulating and testing hypothesis, and explanation and inferring among students : This objective implies :

(i) To help students develop an intellectual decipline necessary to find out data and process it in a systematic manner.

(ii) To develop in the students a way of thinking and to ask questions as to why events happen as they do.

(iii) To develop intellectual strategies among students so as to determine causal relationships among phenomena.

(iv) To develop in students the ability to arrive at generalisations.

2. **To develop among students the strategies for creative inquiry** —This objective includes :

(i) To develop explanation skill in students.

(ii) To give the students a new approach to learning by which they would build concepts through the analysis of concrete episodes and the discovery of relationships between variables.

Apart from the above mentioned main objectives, there are some subsidiary objectives. These are the following :

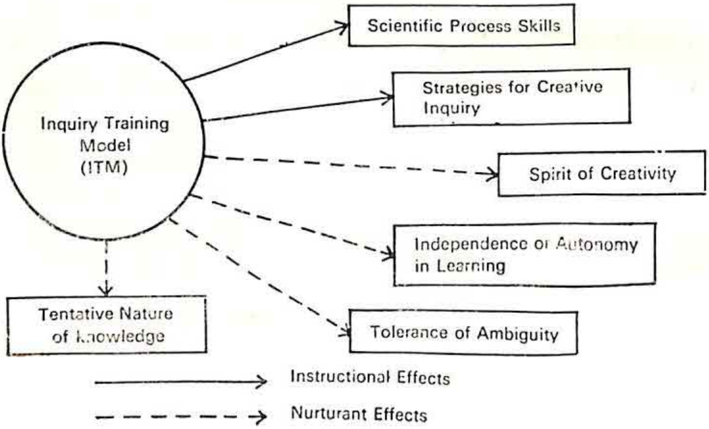
1. **To develop among students an independence or autonomy in learning** : In other words, it means to help students inquire independently in a systematic manner.

2. **To develop among students the ability to tolerate the ambiguity :** During the process of inquiry some of the students may ask ambiguous questions or give ambiguous explanations or even questions that may seem irrelevent. With this model, students learn to tolerate questions and explanations put forward by other students.

3. **To make students understand the tentative nature of knowledge :** It makes students realize that there can be several explanations to what seems to be a single cause-effect relationship.

4. **To develop spirit of creativity among students**—It aims at developing verbal expressiveness.

Joyce and Weil (1985) have advocated that Inquiry Training Model has two types of effects. These are Instructional effects and Nurturant effects. Instructional effects are the direct outcomes of this Model. These have been referred here as the main objectives. On the other hand, Nurturant effects are those that are implicit in the learning environment. These have been referred here as subsidiary objectives. The Instructional and Nurturant effects are diagramatically shown as below in Fig 2.


Inquiry Training Model (ITM)
Scientific Process Skills
Strategies for Creative Inquiry
Spirit of Creativity
Independence or Autonomy in Learning
Tolerance of Ambiguity
Tentative Nature of Knowledge
Instructional Effects
Nurturant Effects

LIMITATIONS OF INQUIRY TRAINING MODELS

The Inquiry Training Model has the following limitations :

1. The model can help in developing explanations on the basis of previous knowledge of the students. But it does not help in teaching primary content or subject-matter. For example, new concepts and formulae.

2. If the information about the puzzle is not presented in the form of a problem requiring explanation, the students cannot effectively arrive at generalizations through inquiry. In such cases simulation may be more useful.

3. This model can be effectively applied in those puzzles where cause-effect relationships exist. In other words, it cannot be applied to puzzles which do not have a cause-effect relationships.

WHAT IS INQUIRY TRAINING MODEL

In Inquiry Training Model, the students are presented with a puzzling situation. This may be presented in the form of an episode, experiment, story, etc. In what-so-ever form it is presented, it must show a discrepancy leading to puzzle.

After the presentation of a puzzling situation, the students are encouraged to ask questions. These questions have to be so worded that they have only a 'Yes' or a 'No' answer. The teacher only responds the questions of students in 'Yes' or 'No' but does not explain the phenomena to students. Whenever a question cannot be replied as a 'Yes' or 'No' response, the teacher asks the student to reword the question. Through such pin-pointed questions, the students gather data.

As the students become aware of the properties of the data, they form hypotheses which guide them in further inquiry. Using their knowledge about the behaviour of objects, students can turn their questions to the relationships among the variables in the situation. This they can do by verbal or actual experiments to test the causal relationships. However, unless they have sufficient information about the nature of the problem, situation and its elements, they are likely to be overwhelmed by many possible causal relationships.

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Finally, the students try to develop a probable theory that fully explains what happened. In other words, they reach the final explanation. It is important to note here, that there can be many explanations for the same discrepancy.

However, the main emphasis in this model is to master the inquiry process and not the content or the explanation of any particular problem situation. For this reason, in the last stage the teacher leads the students to retrace the path through which they have travelled to reach an explanation.

ESSENTIALS OF INQUIRY TRAINING MODEL

There are certain essential conditions that are required during the process of Inquiry. The teacher needs to take note of these.

1. Students need freedom to interact in the inquiry process. Suchman has talked of two types of freedom—external and internal. External freedom means physical freedom to reach out for the desired data and information. Students can acquire this data and information at any rate and in any sequence that they wish. On the other hand, internal freedom is something that follows as a consequence. Suchman has found that when students are given external freedom, they are inhibited for a time and do not avail themselves of it. The reason being that they have been conditioned to follow the teacher's leadership. But eventually, as they explore and find that external freedom does exist, they begin to build autonomy in their operations. They make decisions and try to satisfy their own cognitive needs by gathering the kind of information they want. They also exercise freedom in trying out ideas. In the process of collecting data independently and processing it, two methods are used. One is scanning the field for data and the other is scanning the store of ideas for conceptual Models. Both these are two parts of the inquiry cycle. A student

absorbs a percept and tries to find out a way to assimilate it. If assimilation is incomplete, he perform some action to generate new data. At the same time when he acquires new data, he searches new ways to test the data.

2. Students need some kind of problem or stimulus. They prefer those problems which are discrepant to their conceptual system. Discrepancy creates challenging conditions for the students. In order to solve this situation, they pursue causal relationships. It compells them to gather data. The experience of data gathering is intrinsically rewarding, builds self-confidence, encourages creative intuitiveness, and strengthens cognitive skills.

3. Students need to have a rich environment where they get a feeling of procurring something. It is the motivation which maintains the interest of the students during the inquiry process. Suchman while commenting on motivation operating in this situation says, "When you go into the inquiry model, you start with a problem and the children are forced to attack it and build their constructs as they see fit. Motivation becomes more cognitive and takes two forms. One is the motivation of closure—to close the gaps and to make the match between what is perceived and what is known. But we found that beyond this, after the children had found a reasonable degree of closure, they continued to inquire, to pull in data and to process them. They were motivated, it seemed, by the act of inquiry itself."

Hence when the above mentioned three conditions are provided to students, they get an atmosphere wherein theyare actively involved in the inquiry process to become effective inquirers.

RULES FOR CREATING THE CLIMATE FOR INQUIRY

The main objective of Inquiry Training Model is to make the students more autonomus learners. It is essential that the teacher creates such a climate that aids inquiry. The facilitate this climate for inquiry Suchman provided the following six rules for conducting the Inquiry Session.

RULE 1 : **The questions should be phrased in such a way that they can be answered with a 'Yes' or a 'No'.**

This rule does two things. One is, that it makes students to be more precise in their thinking. Secondly, it prevents the students from putting the burden of thinking on the teacher through open-ended questions.

RULE 2 : **Once called upon, a student may ask as many questions as he/she wishes before yielding the floor.**

This rule is based on the assumption that creative thinking takes time and continuity. Students who take the initiative to ask a question must be encouraged. The encouragement may be provided not only by the teacher through verbal or non-verbal means but also by giving the student a chance to explore as much as he/she can. The idea behind this is that the student should not get put off because of the other students eagerness enquire too.

RULE 3 : **The teacher does not answer 'Yes' or 'No' to statements regarding theories or to questions that attempt to obtain the teacher's approval of a theory.**

The theories are only starting points for inquiries. The teacher should encourage students to go beyond their theories, to experiment and to test them. There are no final answers to a problem. Scientist have always been searching for better theories. Theories are always refined so as to be expressed in the most clear and concise terms. Students explanations, similarly, can be refined. The procedure for inquiry should encourage students to cooperate with one another and build upon the groundwork of others.

RULE 4 : **Any student can test any theory at any time.**

Students should be allowed to argue the merits of one anothers theories and feel free to test all theories that have been put forward.

RULE 5 : **Anytime the students feel a need to confer with one another without the teacher's presence, they should be free to call a conference.**

Sometimes the students cannot frankly discuss their points of view before the teacher. Such students need to be given a free atmosphere to discuss with their own peer group. The purpose of this activity is to help the students who are reluctant to expose their ideas to the teacher, and to facilitate cross fertilization of ideas. This type of discussion may be of a very short duration. A minute or two would do.

RULE 6 : **Inquirers should be able to work with experimental kits, or resource books at any time.**

The student should be allowed to consult source material if they so wish. This will help them in developing sophisticated explanations. They can read about theories (eg. Molecular theory, Evolution theory etc.) and begin to connect the relationships they discover to the problem they are trying to solve. The point here is that the teacher should provide the environment to the students, where in they gather information and then logically develop explanations.

POINTS TO BE KEPT IN MIND BY TEACHERS DURING INQUIRY TRAINING PROCESS

Today, students are not accustomed to guiding their own intellectual study and asking questions. In such a situation, the teacher has to be cautious enough to guide the inquiry training properly. He should keep in mind the following points :

1. Get into the problem situation as quickly as possible : In the beginning of the inquiry training process the students are puzzled. They will not be able to understand the terminology of inquiry training. It is, therefore, advisable to the teacher that he should not dwell on the terminology of inquiry or give instructions about the nature and stages of inquiry. He should, rather, get into the problem situation at the earliest.

2. Maintain students initiative : Inquiry involves risk taking. Some individuals will withdraw at first. It is very much desired that the teacher should encourage the students to take an active part. Eventually the students will become active participants.

3. Answer students questions in a 'Yes' or 'No' manner : The teacher should help students in generating and wording the questions which have 'yes' or 'no' answers. It is important to emphasize that the teacher should take care that students' questions have a hypothesis to test.

4. **Teach Terminology of Inquiry** : The first three points mentioned in this section, hold true during the beginning of the inquiry process. But once the students become more comfortable with the process, the teacher should begin to teach terminology. This may be done by using statements like "That is an interesting theory; how would you go about testing it ?" "Are there any more objects that you should identify ?" "Are there any more conditions you want to explore ?"

In the beginning, select a problem that does not require formal academic training. When the teacher first introduces the students to the inquiry process, he should try to maintain their interest and not allow them to get frustrated. Thus, he should select such problems that do not require formal academic information. These problems may be general.

SYNTAX FOR INQUIRY TRAINING MODEL

In order to use the Inquiry Training Model in a classroom, a teacher has to follow certain steps in a proper sequence. This is known as syntax and steps are termed as phases. There are five phases of this model. These are : Encounter with the problem; Data-gathering-Verification; Data gathering-Experimentation; Formulation of an explanation; and Analysis of Inquiry process. Each one of these is discussed below.

Phase 1 : Encounter with the Problem

This phase, has two parts. The first is that the teacher explains the inquiry procedure to students. The second is where the teacher presents a problem situation.

Explain Inquiry Procedure : In this phase to start with the teacher explains the procedure to be followed during the course of inquiry. It is always advisable that in the first two or three lessons, the teacher should not stress the terminology of inquiry procedure. As it has been pointed out earlier, the teacher should use simple and familiar words. But later on he should introduce and explain the various activities to be followed in the inquiry procedure.

In the beginning or in the first two or three lessons, the procedure of Inquiry may be explained to students in the following manner :

TEACHER : " 'Students', today we shall learn through a new method. To start with I will tell you an incident, a story, or an episode in which you will find a '*conflict*'. You have to give me an explanation for this problem. To give the proper explanation, you need to have more information apart from that what is given in the narration. To collect more information you can ask questions. Your questions should be simple, direct and pin-pointed so that each one of them can be answered by me with a 'Yes' or a 'No'. Once you think that you have collected sufficient information, you may give your explanation. I hope, you have understood the procedure to be followed. But if you have any doubts, you may clarify then now."

After using the Inquiry Training Model, two or three times with the same students, the teacher should explain the procedure of inquiry by using its terminology. The teacher may say the following :

TEACHER : "Students, today we are going to study through a new method known as Inquiry Training. I will tell you an event, episode or a story. You will find a discrepancy (conflict) in the event. For this discrepant event, you have to find an explanation. You can ask me a series of questions to get information in order to verify what happened. Here I have used the word verify which means to prove or to figure out what happened. You already know that your questions have to be pin-pointed and specific. You should word your questions in such a way that I can answer with either a 'Yes' or a 'No'. On the basis of data or facts collected by you through questions, you should try to develop theories or explanations about the discrepant event."

Present Discrepant Event : Once the students have understood the procedure of inquiry, the next task for the teacher is to present the discrepant event. The presentation of a discrepant event needs preparation. While preparing problem or an event, the following points must be kept in mind :

1. The event must pose a problem to the students : The event must pose a problem to the students so as to encourage data gathering and hypothesis testing. If no problem is posed students have no opportunity to begin their inquiry. The distinguishing feature of a discrepancy is that is involves illogicality which conflicts with the notion of reality. In other words every puzzling situation cannot be a discrepant event. It may be puzzling because there is no new concept and we do not know the answer. In such cases, there is no need to con-

duct an inquiry. This is mentioned here because sometimes a problem may be picked up that is not truely puzzling to the students. In these cases, the learning activity does not progress beyond the game of "Twenty Questions". While the questioning activity has its own value, it should not be confused with the notion of scientific inquiry.

2. The problem must match the background of the learner : While framing a problem, the teacher should take care that the level of the problem is approximately matched with the cognitive level of the learner. Suppose a problem is prepared and the students are not able to understand the discrepancy, they will not be able to collect facts. Hence inquiry will not take place.
3. The problem should enhance curiosity and motivation of students : Another consideration while preparing the problem is to take into account the motivation of students. This can be done by relating the problem to the cognitive level of students. Once students are made curious and motivated, they will do their best to find an explanation to the discrepant event.
4. The event should focus on a particular problem. While framing an event, the teacher should consider the scope of the event. This should be narrow enough to provide focus for inquiry activity. The narrowing of the event provides a better sense of activity and makes it easier for them to begin gathering data. The more narrow the focus is, the more are the chances that the entire group of the students views the problem in the same way and reduces misconceptions about the task at hand.

Hints for preparing the problem : Keeping in view the above points, the following hints may help the teacher in framing the problem.

Firstly, the teacher should select a content that has a cause-effect relationship.

Secondly, he should enlist the major causes which give rise to a particular effect. For example, there is an effect Y which is caused by major factors—X1, X2, X3, X4, and X5.

Thirdly, he may word the event wherein factors, say, X1, X2 and X5 are present but the 'Y' effect does not happen. The event may be worded in another way too. The teacher may say that the effect 'Y' occurs even when the major factor(s), say, X4 is not there. In both the cases, the logical occurrence of event should be kept in mind.

The above mentioned points for constructing an event are illustrated through the following example :

"We know that a cheque is honoured (effect) by the Bank when the date is properly written, name of the bearer is neatly written, the amount is written both in figures as well as in words, the signature of the account holder is there, etc. All these are the causes for honouring the cheque."

For this the discrepant event may be worded as : "Ram has an account in the State Bank of India. He has a balance of Rs. 5000 in his account. He sent a cheque for Rs. 400 through Patel. He got Ram the amount. After 20 days Ram again wanted to withdraw Rs. 600. He wrote a cheque and sent it through Patel. It was reported by Patel that the cheque had been dishonoured." What is the discrepancy in this event ?

Medium for presenting the Event : After framing the event, the teacher has to choose an appropriate medium for presenting the event. Films, audio-tapes, demonstration, graphs, tables, maps, case studies, verbal connotation etc., can be used for presenting the event. The actual selection of the medium is to be done after the content and the type of event has been chosen. Other factors such as characteristics of the learner, conceptual background, facility with different levels of abstraction, and skill in data gathering should also be considered while selecting the medium.

In phase one, the task of the teacher is to explain the inquiry procedure and present the problem. Before presenting the problem or event, he selects the problem, and medium for its presentation. After this the teacher presents the problem as follows :

"Students, just now I have explained the procedure of the inquiry training. Now I will tell you the event."

Here are two beakers of colourless liquid. Now I put an ice cube into each of the containers of the fluid. You can see that ice cube floats in one of the beakers and sinks in the other. The two liquids appear to be similar and the ice cubes are nearly identical. Now tell me what is the discrepancy in this event ?"

Before proceeding further, the teacher must ensure that students are able to understand the event and see the discrepancy.

Phase 2 : Data Gathering-Verification

In this phase the teacher helps student collect data by verification. Students verify the nature of objects, conditions, and the occurrence of the problem situation. As explained in phase one, students collect all the above information or data by asking questions which have a 'yes' or a 'no' answer.

Some of the information is always there in the problem itself which is presented by the teacher during phase one. This information is not sufficient enough to come to an explanation of the discrepancy. The students asks questions to gather four types of information, viz., infromation about objects, events, properties and conditions. With respect to the problem given in phase one, the students may ask the following questions for verification :

1. —Are the beakers of same size ?
2. —Do the liquids have similar density ?
3. —Were the beakers kept in the same position ?
4. —Did the ice cube sink in first beaker but not in the other ?

In the above problem under consideration, beaker, ice cube and liquid are objects. The first question, viz., "Are beakers of the same size ?" is related to the object : beaker. These objects have their specific properties in the problem. The properties of all the objects iu the problem may not lead to the explanation of the discrepancy. In this problem the properties of objects, like, liquid and ice cube seem to be very much related to the explanation for the discrepancy. Thus, the second question, "Do liquids have similar density ?" is related to the properties of the object (liquid). The third question "Were the beakers kept in the same position ?" is related to the conditions. The information related to the condition may help in giving the explanation of the discrepancy. Further, in the problem under consideration, there are two events—In one of the beakers the ice cube sinks. In another beaker the ice cube does not sink. These events conflict to each other. The fourth question, viz., "Did the ice cube sink in first beaker but not in the other ?" is related to the event. Thus, the students collects information or data about objects, properties, conditions and events in order to find an explanation for the discrepancy. The student may not collect information about each one of them rather he may concentrate on any one or more, whichever he thinks may lead him to the explanation.

Why Special Questions : The students are prompted to ask pin-pointed questions which can be answered with a 'yes' or a 'no'. This eliminates open-ended questions. Students do not ask the teacher to explain the phenomenon to them. They have to focus and structure their probing in order to solve the problem. In this way, each question becomes a limited hypothesis. For example, students may not ask a question, like, "How did the density of liquid effect the sinking of ice cubes ?" but may ask, "Is the density of one liquid in which ice cube sinks greater than the other liquid in which the ice cube does not sink ?" the first question is not pin-pointed and does not state what information is desired rather it asks the teacher to do the conceptualization. The second question is a specific question and asks the student to put many factors together like density of the liquid, the sinking of ice etc. The student here ask the teacher to verify the hypothesis that he or she has developed (the density causes the ice cube to sink or float).

Many-a-times students may word a question which cannot be answered by a 'yes' or a 'no'. In such a case teacher reminds the students of the rules of the game and waits until they themselves phrase the question in the proper form. Comments such as "Please reframe the question so that I can answer it with a 'yes' or a 'no' ?" ; "Please be specific in your question"; "Re-state your question by replacing the vague word, 'like', 'more', 'small', 'many', etc. with a specific word" may be made by the teacher during the process of inquiry.

The use of worksheet : As it is apparent that students ask large number of questions. Each question is important in the inquiry process. It is quite possible that students may think of a large number of questions. And while getting answers to these questions they may forget a few. Thus, there is a need to record all these questions. For this purpose a worksheet is designed. The worksheet is given in...........It makes the inquiry process systematic. It helps students to have a line of thinking to gather data logically. All this facilitates in developing explanations. Above all, the worksheet is helpful for the Analysis of Inquiry Process (Phase Five), wherein students have to recall not only the questions but also the sequence in which the questions have been asked.

To start with the teacher will ask all students to draw the worksheet as given on the blackboard. After the discrepancy has been made clear the teacher gives the student time to write down all those questions that came to their mind. There may be some questions which a student could not think of but was put forward by another students during the process of inquiry. These questions may be added in the worksheet, if the students feels that those will help in formulating an explanation. The students ought to write the teacher's answers to the questions. This will provide basic data to the students. All questions replied in a 'yes' or a 'no' are equally important in forming an explanation for the discrepancy.

Phase 3 : Data Gathering—Experimentation

In this phase the teacher helps the students to collect data through experimentation. The students introduce new elements into the situation to see if the event happens differently. Experimentation serves two functions, that is, exploration and direct testing. Exploration means changing things just to see what will happen. It is a random process and is not guided by a theory. Direct testing occurs when students frame a hypothesis utilizing a theory. This hypothesis determines the direction of data gathering. If the data gathered support the hypothesis, then the hypothesis is retained as part of the explanation. If the hypothesis is rejected because of the data collected, then alternate hypotheses are formed and the cycle continues.

In this phase students may ask the following questions :

1. If the beakers are of smaller size, then will the ice cube sink ?
2. If the liquids have low density, then will the ice cube sink ?
3. If the beakers are tilted at an angle of 60°, then will the ice cube sink ?
4. If the liquids are interchanged, then will the ice cube sink again in the same beaker ?

The first question mentioned above relates to objects, second question relates to properties, third question relates to conditions, and fourth to events. All these questions are of experimentation type where students go for verbal experimentation. That is, they ask questions that rearrange the situation. Students verbally substitute new elements and conditions through the use of "If......then" in their questions. Such questions are particularly important when students are not in a position to perform experiments physically. This way of experimentation is more useful in social sciences. On the other hand, in physical sciences where experimentation is physically possible, the students may seek answers to "If...then" questions overtly rearranging actual objects. This is known as manipulative experimentation. The purpose of verbal and manipulative experimentation is to isolate variables so as to test casual-relationships.

Typically during the first few inquiring sessions, students gather data almost at random or without a sense of direction.

They may also propose explanation which do not relate to data or they may gather data which are not related to the explanation. However, after students acquire experience with inquiry, they become more efficient. Their data gathering become directed towards consciously testing a hypothesis and explanations are developed to consciously account for available data. During the process of questioning the teacher may think that students are asking irrelevant questions. In such circumstances the teacher need not discourage the student but he may ask about the theory behind the question. That is, teacher may say "What did you have in mind when you asked that question"; or "On what basis are you asking this question" etc. These questions by the teacher not only guides the student's inquiry process but they also discourage irrelevant thinking on the part of the students.

Although verification and experimentation are described as separate phases of the model, yet students' questions can alternate between these two aspects of data gathering. Thus, the teacher need not have to follow Phase Two and Phase Three in a particular order. Rather he should encourage students to follow these two phases in such a way that an explanation is built.

It is quite possible that students ask verification and experimentation questions which are not directly related to the solution of the problem. Such questions may waste the time and discourage the students. In such a situation, the teacher should direct their inquiry towards finding a solution by making statements like, "Ask more questions in the same direction as asked by Mr. X", "Ask more questions about properties, objects, events, or conditions", "More questions in the same line of thought as Mr. X can lead to a solution".

Phase 4 : Formulation of as Explanation

In this phase the teacher helps the students to formulate an explanation on the basis of data gathered through verification and experimentation. They make a formal explanatory statement of the problem. This in other words is also called theory formation. In this phase, different students may put forward different explanations. So even after an exhaustive and apparently resolved inquiry several explanations are possible. Students may realise that same set of data can suggest different explanations to different individuals. This is one of the best ways to realise the assumption that all knowledge is tentative.

LEVELS OF THEORY BUILDING

Explanations or theory building can take place at four levels as suggested by Suchman. These are :

—Simple linear causation
—Theories of properties
—Analogies
—Application of a generalization or principle.

1. **Simple linear theories** are developed on the principle that X causes Y. For example, density of a liquid causes ice cubes to float. Heat causes the bending of metals. Suchman has pointed out that one can never prove a linear theory but one can try to disprove it by manipulating the cause (X) in different ways.

2. Another level of theory building can result from questions aimed at determining the **properties of the objects** in question and postulating a theory based on the behaviour of these properties. For example, ice cubes may sink or float in the liquids depending upon their density. Another example, different metals expand at different rates, and differences in the rate of expansion produce the bending of a blade.

3. The third level of theory building is achieved by making **analogies**. This means taking examples which are similar in their theme. For example, "Ships float at a different level in sea water, and at another level in fresh water". This is an anology for "ice cubes sink or float according to the density of the liquid."

4. In the fourth level of theory building students **apply generalizations** or concepts from other events. For example, a

student might have developed the concept of equilibrium while observing the motion of certain objects. He may theorize that the blades bend because the equilibrium has been disturbed and the blade is subjected to unbalanced forces.

It has been experienced that some students have difficulty in making an intellectual leap between the information that they have gathered and clear explanation. It is quite possible that they give inadequate explanations omitting essential details. Sometimes several theories or explanations are possible based on the same data. In such circumstances, it is always useful to ask many students to state their explanations so that the range of differences is revealed. The group together shape the explanation that fully satisfies the problem situation.

In this phase, we have described four levels of theory building. The students can form an explanation of any level. For building an explanation or theory of a higher level, the teacher can help the students by suggesting resource books that describe fields of study. The theories, principles, or concepts given in these books can be ideal support material for the inquiry process. The support material has not be constructed as solutions to any one problem, rather they are used for gathering knowledge that can be brought to bear on the problem. In other words, it is not a matter of finding the answer but of locating and applying information.

Phase 5 : Analysis of Inquiry Process

In this phase students are asked to analyse their pattern of inquiry. They may find out the questions that were most effective, the line of questioning that was productive and those that were not, or type of information they needed and could not obtain. The teacher asks students to consult their worksheet on which they have written the questions raised by them. They are, further, asked to identify those questions which led to the explanation The students try to analyse how those questions lead to explanation but not other questions. The teacher can take one of the questions raised by a particular student and ask him what was in his mind when he came up with it. During this process, the teacher points out to students verification and experimentation types of question. Along with this, the teacher recapitulates the different steps followed in the process of inquiry.

PRINCIPLES OF REACTION

It tells the teacher how to regard the learner and respond to what the learner does. In this model, the most important reactions of the teacher takes place during the second and the third phases. In the second phase, the task of the teacher is to help the students to inquire but not to do the inquiry for them. Many-a-times students may ask questions that cannot be answered with a 'yes' or a 'no'. In such situations, the teacher must ask the students to rephrase their questions so that their attempt to collect data progress smoothly. The teacher can if necessary keep the ball of inquiry rolling by making new information available to the group and focus on a particular problem even by raising question. The task of the teacher in Phase Five is to analyse the inquiry process on the whole. His task can be summed up as given by Joyce and Weil (1978).

1. Insuring that questions are phrased so, that they can be answered in a 'yes' or a 'no' manner.
2. Asking students to rephrase invalid or vague questions.
3. Pointing out unvalidated statements. For example, "We have not yet established that this is a liquid".
4. Using the language of inquiry process. For instance, identifying student's questions as theories, and inviting experimentation.
5. Neither approving nor rejecting students theories.
6. Pressing students for cleaner statements of theories and more support for generalisations.
7. Encouraging interactions among students.

SOCIAL SYSTEM

It describes the role of the teacher and students with regard to their relationships and the kinds of norms that are encouraged. This model is based on the assumption that team approach is better than the individual approach. So the social system here is co-operation. Although the teacher plays a dominant role, yet the intellectual environment is open to all relevant ideas. The teacher and students participate as equals where ideas are concerned. In the first few lessons the teacher plays a dominant role but as the students progress the teacher encourages students to initiate inquiry as much as possible. The students learn the principle of inquiry in their pursuit of explanation of a discrepant event. In the later lessons the environment becomes quite open and discussion follow smoothly. The teacher's role, student's role and classroom procedure are explained in the following paragraphs :

1. **Teacher's Role**—In this model, the teacher has a large number of tasks to perform. These are : he selects the problem situation ; acts as refree in the inquiry, responds to students' inquiry, probes with necessary information, helps beginners to focus on the inquiry process, facilitates discussion of the problem situation among students, acts as a recorder, keeps track of inquiry by recording theories and types of questions on the black-board, and helps students to arrive at explanations.

2. **Student's Role**—Students play an active role in this model. They find out the discrepancy from the problem, and probe by asking pin-pointed questions which can be answered by a 'Yes' or a 'No'. Before putting forward their explanations, they go for experimentation by verbally rearranging the situation or manipulating actual objects. Later on they arrange the data logically and give different possible explanations. In the few beginning lessons, students may be helped by the teacher in all these activities. But once they have gone through some lessons, they may undertake the inquiry process on their own by following various steps.

3. **Classroom Procedure**—This model emphasizes group activity. The students can sit in small groups and discuss among

themselves about the discrepant event. They can arrange their seats for this purpose. They can consult the library, perform experiments, go out of the class to bring in some material from the environment, etc. This requires an open classroom climate where the teacher acts as an instructional manager and monitor.

SUPPORT SYSTEM

It refers to additional requirements beyond the usual human skills, capacities, and technical facilities to implement the model in the teaching-learning process. The main requirements of this model are a set of discrepant events, teacher's knowledge about the inquiry process, and resource material related to the problem. With this support system, inquiry training can be easily implemented.

The inquiry training model has been researched upon to find out the feasibility of its being used. The results of the feasibility studies are presented in the next chapter. In the last chapter, the lesson plans alongwith the transcripts are presented. It will help the readers in planning the lesson.

3

Feasibility Of Inquiry Training Model

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INTRODUCTION

Suchman's model is supposed to enable pupils to establish facts, build concepts and generate theories for explaining the phenomena. Thus explanation of causation is the special feature of the model. Suchman (1961) designed the model mainly to develop scientific process skills in the pupils. The assumption of the model has been that, a puzzling situation creates powerful stimuli to the students to question and explore the data. This facilitates improvement in thinking in the desired direction. In this process the pupils are made familiar with the language of inquiry. One of the fundamental principles of the model is that all knowledge is tentative, i. e., nothing is permanent, everything is changing and growing. It is on the basis of this fundamental assumption, the Inquiry Training Model (ITM) is thought to be very useful to train pupils build new theories and answers to the old problems.

To implement this model in the classrooms the teachers have to be trained. What will be the intellectual and emotional responses of the teachers ? Are they willing to implement the model ? These are some of the important questions which need to be studied.

In the first place, the teacher should have a thorough theoretical understanding of the model. Hence, it is necessary to know what type of teachers are required to handle ITM. What level of intellectual capacity is needed to understand the model. Secondly, it is important to know their opinions and reactions towards the various aspects of the model. It is also essential to know how far they are willing to undergo further training and implement the model in the actual classroom. Unless and until these questions are answered it may not be possible to introduce ITM in the real classroom situations.

Keeping the above points in view many researchers have conducted various studies in the area of Models of Teaching Passi, Singh and Sansanwal (1985), D'Lima & Lobo (1985), D'Lima & Sugandhi (1986) have tried to find out the intellectual and emotional responses of the trainees towards ITM.

In this chapter a brief outline of the studies conducted is given. The studies are classified as follows :

A. Theoretical Understanding of the Model

- (a) Theoretical Understanding by Teacher Educators.
- (b) Theoretical Understanding by Student Teachers.

B. Reactions Towards the Model

- (a) Reactions of Teacher Educators.
- (b) Reactions of Student Teachers.

C. Willingness to Implement the Model

- (a) Willingness of Teacher Educators.
- (b) Willingness of Student Teachers.

A. THEORETICAL UNDERSTANDING OF THE MODEL

After orienting the participants to the model it is advisable to check their theoretical understanding of the model. The analysis of theory checkup helps the trainer to know the effectiveness of his orientation and the need for clarification of misunderstood concepts. Weil and Joyce (1978) have developed theory checkups for various models for this purpose.

Theoretical Understanding of the Inquiry Training Model was one of the indicators of the effectiveness of the orientation to the model. Several studies were conducted to find the understanding of the theoretical aspects of ITM. The following were the two tools used to measure the theoretical understanding : Theory Checkup developed by Bruce Joyce and Marsha Weil (BTC 1978), and Indore Theory Checkup on ITM (ITC 1985).

The above tools were used on teacher educators, and student teachers undergoing training in ITM.

(a) Theoretical Understanding of the Model by Teacher Educators.

Passi, Singh and Sansanwal (1985) studied the effectiveness of training in ITM on teacher educators. To find out the effectiveness of training in ITM, the Theory Checkup developed by Weil and Joyce (1978) was administered to the teacher educators before the orientation to the model. The scores on this theory checkup constituted the Test I Scores. After the subjects were given training in ITM, they were administered Indore Theory Checkup (ITC) developed by Budhisagar, Dubey and Sansanwal (1985). The scores on this theory Checkup constituted the Test II Scores. Since the two theory tests were not parallel in terms of difficulty level, number of items and coverage of content, the test results were analysed by computing the Rank correlation between Test I and Test II Scores. The Mean Scores (M); Standard Deviation (SD); Coefficient of Variation (CV) and Rank Correlations were computed and results are given in Table 1.

TABLE 1

	N	*M*	*SD*	*CV*
Test I	44	3·36	1·83	54·46
Test II	44	31·29	8·04	25·69
Rank Correlation :	0·26			

It was found that before training, the group was heterogenous with respect to the understanding of theoretical aspects. After the training the group became more homogenous because the subjects developed understanding of theoretical aspects of the model.

The low Rank Correlation Coefficient (0·26) indicated a shift in the rank positions of subjects after training in ITM.

The mean achievement score on Test II of the subjects was 31·29. This was much higher than the expected chance score which the subject could earn without knowing anything about the theory of the model. Hence, it was concluded that the training provided to the subjects in ITM did bring about high level of understanding about the theoretical aspects of the model. Therefore, it was concluded that training in ITM was effective in terms of understanding.

(b) Theoretical Understanding of the Model by Student Teachers

In a study conducted by D'Lima & Lobo (1985) seventy two Graduate Student Teachers were exposed to theory cum demonstration sessions on ITM for three days. At the end of the programme they were tested for the theoretical understanding of the model using Bruce Joyce and Marsha Weil Theory Checkup (BTC). The total possible score on BTC is 14. The Mean BTC score for the entire group was found to be 9·82 and the SD was 1·90. This was much higher than the expected chance score which the subject could earn without knowing anything about the theory of the model.

To know whether it is necessary to have high reasoning ability for better understanding of the Inquiry Training Model, the Graduate Student Teachers were given Abstract Reasoning Test from the Battery of the Differential Aptitude Test prepared by Bennett, Seashore and Wesman.

The Table 2 indicates the Means (M) ; Standard Deviations (SD) ; Standard Error of Mean (SEM) ; Difference between the Means (D) ; Standard Error of the Difference (SED) ; and Critical Ratio (t) of High and Low Abstract Reasoning Groups.

TABLE 2

Group	*N*	*M*	*SD*	*SEM*	*D*	*SED*	*t*
HAR	18	10·44	1·46	0·34			2·29*
LAR	18	8·88	2·47	0·58	1·55	0·67	

The t value (2·29) is significant at ·05 level, with df of 34. This indicates that there is significant difference in the mean BTC score of High and Low Abstract Reasoning groups. The mean BTC score of High Abstract Reasoning group is significantly higher as compared to their counterparts of Low Abstract Reasoning group. Students with High Abstract Reasonnig understood theoretical aspects of ITM significantly more than students with Low Abstract Reasoning. Thus, higher the abstract reasoning possessed by students, high will be the theoretical understanding of the model.

In another study conducted by D'Lima and Sugandhi (1986), Seventy Six Graduate Student Teachers were trained in ITM through theory lectures and demonstrations. When tested on Bruce Joyce and Marsha weil Theory Checkup (BTC), the Mean BTC Score for the group was found to be 7·96 and the SD was 1·70. Although this Mean BTC Score was lower than that of the D'Lima and Lobo (1985) study, yet it was still higher than the expected chance score which the subject could earn without knowing anything about the theory of the model.

To find out whether there is any significant difference on theoretical understanding between the group high on Abstract Reasoning and the group low on Abstract Reasoning, the t-test analysis was done. The Table 3 presents the results of the analysis :

TABLE 3

Group	*N*	*M*	*SD*	*SEM*	*D*	*SED*	*t*
HAR	19	8·15	2·00	0·46			0·70
LAR	19	7·73	1·66	0·38	0·42	0·59	

The t-value (0·70) is not significant. This study did not indicate any significant difference in the mean BTC scores of High and Low Abstract Reasoning Groups. This reflect that abstract reasoning ability does not influence the understanding of theoretical aspects of ITM. This finding is not supported by the finding of study conducted by D'Lima and Lobo (1985).

In a study reported by Passi, Singh and Sansanwal (1986), and conducted, at Sangli, Kurukshetra, and Chandhigarh the mean score on Indore Theory Checkup (ITC) of seventy two Graduate Student Teachers after training in ITM was 24·92 with the SD of 5·21. The mean achievement score of students is much higher than that of the expected chance score. Therefore, it was concluded that training given to students in ITM did bring high level of understanding about the theoretical aspects of ITM.

In view of these studies it may be concluded that the training in ITM was found to be effective in terms of understanding of ITM as measured by BTC and ITC.

However, it is very essential to find out which aspects of the ITM are yet not understood by the participants. Experience of the researchers in ITM indicated that the participants failed to distinguish the type of data questions (object, event, condition and property), as well as difference between the levels of theory building. Although the participants who had undergone training in ITM were able to recall and recognise the different levels of theory building, yet they failed to understand the difference between 'simple linear causation', 'theories of properties', and 'application of generalisation'. Further understanding what is meant by 'analogies' and how to give analogies from other disciplines was also not easily grasped by the participant. Neither BTC nor ITC tested the understanding of these aspects of the model. This suggests a need for a comprehensive theory checkup.

B. REACTIONS TOWARDS THE MODEL

The feasibility of ITM depends upon how the participants trained in ITM, react towards it. An unfavourable reaction would mean that it is difficult to introduce the model at school level. It is important to know what the reactions of the participants are towards ITM, especially of the teacher educators who will have to train the student teachers who finally implement the model in the school.

A few studies have been undertaken to know the reactions of the teacher educators and the graduate student teachers who were trained in the Inquiry Training Model. They may be classified as follows :

(a) Reactions of Teacher Educators Towards ITM.
(b) Reactions of Student Teachers Towards ITM.
(c) Reactions of Teacher Educators Towards ITM.

Passi, Singh and Sansanwal (1985) studied the reactions of 27 teacher educators during post theory demonstration stage and again during post practice stage. For this purpose they used a Reaction Scale prepared by Sansanwal & D'Lima (1985). This scale consisted of 16 items to be answered on a five point scale. The maximum score one could earn was 80. The data were analysed with the help of t-test. The results are given in table 4.

TABLE 4

Stage	*N*	*M*	*SD*	*CV*	*t*
Post Theory Demonstration	27	65·11	5·88	9·03	1·47
Post Practice	27	66·67	4·99	7·48	

The results indicated that the mean reaction scores at Post Theory Demonstration Stage and Post Practice Stage were favourable as the means scores were much higher than 48 which would have been obtained by the group if the reactions were undecided.

The t-value (1·47) indicated that the difference between the two mean values is not significant. Therefore it was concluded that the practice in ITM did not change the reactions of the participants towards ITM. They continued to have favourable attitudes.

Chi-square analysis was done to find out if there was any significant difference in the reactions of teacher educators with high and low theoretical understanding.

The Table 5 presents the frequency distribution and chi-square values of post practice stage reactions towards Inquiry Training Model of the high and low achievers amongst the teacher educators oriented to the model :

TABLE 5

No.	*Items*	*GRP*	*F*	*N*	*U*	χ^2
1.	It provides opportunity to think independently	HA	24	0	0	0·02
		LA	18	0	0	
2.	I get frustrated when my hypothesis gets rejected.	HA	2	2	20	2·89
		LA	4	3	11	
3.	It helps in developing independent study-habits.	HA	20	2	2	2·93
		LA	17	1	0	
4.	I get motivated when I see others asking questions.	HA	23	1	0	3·57
		LA	15	1	2	
5.	It does not provide freedom for thinking.	HA	0	0	24	2·08
		LA	0	1	17	
6.	The other subjects should also be taught by the method.	HA	16	5	3	0·58
		LA	13	3	2	
7.	It does not help in developing self-confidence.	HA	1	3	20	3·16
		LA	1	0	17	
8.	I remain active while teaching through this model.	HA	22	2	1	2·55
		LA	17	1	0	
9.	It is not conducive to develop scientific process skills.	HA	3	0	21	0·91
		LA	0	3	15	

No.	*Items*	*GRP*	*F*	*N*	*U*	χ^2
10.	I can develop new hypotheses based on other's questions.	HA	24	0	0	3·01
		LA	16	2	0	
11.	I feel exhausted quickly while teaching through this model.	HA	3	2	19	1·26
		LA	4	1	13	
12.	It is time consuming yet no thorough understanding of the subject.	HA	5	4	15	0·51
		LA	4	4	10	
13.	This model is good for learning how to ask pin-pointed questions.	HA	24	0	0	2·08
		LA	17	1	0	
14.	It does not help in developing analytical ability.	HA	0	2	22	2·57
		LA	1	1	16	
15.	It is difficult to maintain discipline during teaching.	HA	2	3	19	7·64
		LA	7	3	8	
16.	Without any hesitation I can ask questions.	HA	21	1	2	1·04
		LA	16	1	1	

F=Favourable ; U=Unfavourable ; N=Neutral ; GRP=Group

From the Table 5 it is evident that no chi-square value is significant. Hence, Passi, Singh and Sansanwal concluded that subjects belonging to high and low categories of achievement in theory checkup did not differ significantly in their reactions. This perhaps means understanding of ITM does not effect the subjects reactions towards ITM.

D'Lima & Lobo (1985) studied the reactions of 18 teacher educators after exposing them to theory, discussion and demonstration. The Reaction Scale prepared by Passi and Sansanwal (1985) was used. This scale consisted of ten items to be answered on a five point scale. The maximum score one could earn was 50. The Table 6 presents the data obtained:

TABLE 6

N	*M*	*SD*	*CV*
18	40·66	3·59	8·84

The results indicated that the Mean Reaction Score at post theory discussion and demonstration stage were favourable as the mean score was higher than 30 which would have been obtained by the group if the reactions were 'undecided'. The coefficient of variation value is 8·84 (Vide Table 6). This value is quite low. It indicates that within group differences are less. In other words, group was homogeneous in respect of favourable reactions towards ITM.

(b) Reactions of Student Teachers Towards ITM

Reactions of the following different types pre-service Graduate Student Teachers towards Inquiry Training Model were studied by D'Lima and Lobo (1985) :

1. Student Teachers with High Theoretical Understanding (HBTC) and Low Theoretical Understanding (LBTC) of the Inquiry Training Model.
2. Student Teachers with High Abstract (HAR) and Low Abstract Reasoning (LAR).

The Theoretical Understanding of the Model was measured by using the theory checkup developed by Bruce Joyce and Marsha Weil (1978). The Abstract Reasoning Ability was measured by using the Abstract Reasoning Test of the Differential Aptitude Battery prepared by Bennett, Seashore and Wesman. The reactions were measured by using the scale developed by Passi and Sansanwal (1985).

Seventy two Pre-service Graduate Student Teachers were oriented to the model through theory cum demonstration sessions for three days. The extreme groups were formed by selecting the top 18 (25%) and botton 18 (25%) from the entire group based on the scores on Theoretical Understanding (BTC) and Abstract Reasoning (AR).

The Table 8 presents itemwise test analysis of the data obtained through the Reaction Scale towards ITM of the different types of Pre-service Graduate Student Teachers :

(1) High on Theoretical Understanding (HBTC=18) and
Low on Theoretical Understanding (LBTC=18).

(2) High on Abstract Reasoning (HAR=18) and
Low on Abstract Reasoning (LAR=18).

TABLE 7

No.	*Items*	*GRP*	*M*	*SD*	*t*
1.	I find it difficult to understand the puzzling problem.	HBTC	4·111	0·567	
		LBTC	3·611	0·891	2·01*
		HAR	4·056	0·024	
		LAR	3·778	0·629	1·448
2.	I feel this model makes me understand how to solve problems on my own.	HBTC	4·167	0·500	
		LBTC	4·111	0·657	0·287
		HAR	4·000	0·745	
		LAR	4·222	0·533	1·014
3.	I think this model does not provide sufficient scope to think independently.	HBTC	4·333	0·471	
		LBTC	4·056	0·621	1·514
		HAR	4·500	0·764	
		LAR	4·167	0·373	1·665
4.	After learning through this model I have developed a liking to solve problems.	HBTC	4·111	0·567	
		LBTC	4·278	0·558	0·888
		HAR	4·111	0·657	
		LAR	4·222	0·533	0·555
5.	I feel it is not conducive to develop scientific process skills	HBTC	4·111	0·458	
		LBTC	3·444	0·762	3·176*
		HAR	4·167	0·500	
		LAR	5·222	0·711	4·609*

No.	*Items*	*GRP*	*M*	*SD*	*t*
6.	I think this model is best suited for learning how to ask pin-pointed questions.	HBTC	4·333	0·471	
		LBTC	4·111	0·809	1·000
		HAR	4·444	0·497	
		LAR	4·000	0·882	1·842
7.	I think it is difficult to maintain discipline during teaching.	HBTC	3·000	0·816	
		LBTC	2·778	0·975	0·740
		HAR	2·889	0·809	
		LAR	3·056	1·223	0·485
8.	I think it is time consuming yet no thorough understanding of the subject.	HBTC	3·889	0·567	
		LBTC	3·556	0·685	1·593
		HAR	3·778	0·533	
		LAR	3·889	0·458	0·665
9.	I feel exhausted while learning through this model.	HBTC	4·333	0·471	
		LBTC	4·056	0·524	1·669
		HAR	4·167	0·500	
		LAR	3·889	0 657	1·426
10.	I remain active while learning through this model.	HBTC	4·444	0·497	
		LBTC	4·440	0·497	0·000
		HAR	4·611	0·487	
		LAR	4·333	0·471	17·59

The results presented in Table 7 indicate that the group with High Theoretical Understanding does not find it difficult to understand the puzzling problem. Both the groups High on Theoretical understanding and High on Abstract Reasoning feel that the model is conducive to develop scientific process skills. There is no significant difference in the opinion of different types of groups on the remaining items of the scale.

Passi, Singh and Sansanwal (1986) studies the reactions of seventy graduate student teachers belonging to three different universities (Department of Education, Kurukshetra; Department of Education, Punjab University ; S.P.S. College of Education, Sangli). For this purpose they administered the reaction scale developed by Passi and Sansanwal (RS1) immediately after Post

Theory Demonstration Stage and the Reaction Scale developed by Sansanwal and D'Lima (RS2) at Post Practice stage. Both the scales consisted of ten items to be answered on a five point scale. The maximum score one could earn was 50. The Table 8 presents the results obtained after analysing the data.

TABLE 8

Stage	*N*	*M*	*SD*	*CV*
Post Theory Demonstration	70	36·029	5·964	16·553
Post Practice	70	38·143	6·318	16·564

The results indicated that the Mean Reaction Score at Post Theory Demonstration Stage and Post Practice Stage were favourable as the mean scores were much higher than 30 which would have been obtained by the group if the reactions were undecided. The coefficients of variation at Post Theory Demonstration and Post Practice stages are nearly same and low. It indicates that within group variations at both stages were low. That is, there was less hetrogenity in respect of reactions towards ITM. Majority of students in a group seem to express favourable reactions towards ITM.

A study was conducted by D'Lima and Sugandhi (1986) to find out the reactions of the following different types of Pre-Service Graduate Student Teachers towards The Inquiry Training Model.

1. Student teachers with High Theoretical Understanding (HBTC) and Low Theoretical Understanding (LBTC) of ITM.

2. Student teachers with High Abstract Reasoning (HAR) scores and Low Abstract Reasoning (LAR) Scores.

A Reaction Scale consisting of twenty three items, to be rated on a five point scale was prepared after consulting experts in models of teaching. Item Analysis was done and only those items which had high discriminating value were retained. The reliability of the scale as found by test-retest method was 0·73. The Theoretical Understanding of ITM was measured by using the theory checkup developed by Bruce Joyce and Marsha Weil (1978). The entire group of 76 pre-service graduate student teachers were divided into two extreme groups (top Quartile and bottom Quartile based on their scores on theory check up).

Table 9 presents itemwise results of analysis of the data obtained through the Reaction Scale towards ITM of Pre-Service Graduate Student Teachers. High on Theoretical Understanding and Low on Theoretical Understanding ; as well as High on Abstract Reasoning and Low on Abstract Reasoning.

TABLE 9

No.	*Items*	*Group*	*M*	*SD*	*t*
1.	I find it difficult to formulate a discrepant event.	HBTC	3·316	0·820	
		LBTC	3·368	0·895	0 187
		HAR	3·368	0·895	
		LAR	3·053	0·911	1·075
2.	While teaching through this model, I think it is difficult to analyse the thinking process of pupils.	HBTC	3·316	1·003	
		LBTC	3·474	1·124	0·457
		HAR	3·632	1·212	
		LAR	2·895	1·243	1·971*
3.	A teacher will be more active while teaching through ITM compared to ordinary as teaching.	HBTC	4·684	0·946	
		LBTC	4·158	1·119	1·565
		HAR	4·421	1·121	
		LAR	4·105	1·049	0·898
4.	Creative thinking of children can be stimulated through this model of teaching.	HBTC	4·579	1·017	
		LBTC	4 579	0·961	0·000
		HAR	4·842	0·501	
		LAR	4·737	0·733	0·520

No.	*Items*	*Group*	*M*	*SD*	*t*
5.	It is not suited to the present classroom setting of 60 to 70 students.	HBTC	3·053	1·311	
		LBTC	2·632	1·165	1·047
		HAR	2·684	1·057	
		LAR	2·684	1·204	0·000
6.	It makes pupils alert and attentive.	HBTC	4·842	0·375	
		LBTC	4·053	1·026	2·169**
		HAR	4·842	0·375	
		LAR	4·474	0·513	2·555*
7.	I do not feel competent to handle the various phases of the model.	HBTC	3·316	0·820	2·038*
		LBTC	2·784	0·787	
		HAR	3·842	0·898	
		LAR	2·789	0·631	2·212*
8.	This model teaches pupils not to react without thinking.	HBTC	4·105	1·487	
		LBTC	4·053	1·079	0·124
		HAR	4·263	1·284	
		LAR	3·579	1·539	1·490
9.	This model trains the pupils to view a situation from various angles.	HBTC	4 842	0·375	
		LBTC	4·632	0·496	0 667
		HAR	4·684	0·478	
		LAR	4·526	0·772	0·763
10.	This model develops the spirit of scientific inquiry among students.	HBTC	4·789	0·419	
		LBTC	4·526	0·612	1·547
		HAR	4·737	0·452	
		LAR	4·636	0·684	0·531
11.	There is a chance of the pupils getting frustrated when they are not able to find the solution.	HBTC	3·053	0·970	
		LBTC	2·684	0·885	1·23
		HAR	3·053	1·129	
		LAR	2·526	1·020	1·510
12.	It discourages the pupils from thinking	HBTC	3·684	1·250	
		LBTC	2·842	1 608	1·803

No.	*Items*	*Group*	*M*	*SD*	*t*
	that theirs is the only right answer.	HAR	3·211	1·584	
		LAR	3·210	1·084	0·002
13.	Strict adherence to the rules of the model destroys the pupils creative spirit.	HBTC	3·158	1·385	
		LBTC	3·895	0·809	1·997*
		HAR	3·842	1·068	
		LAR	3·526	0·964	0·958
14.	It is time consuming yet there is no thorough understanding of the subject-matter.	HBTC	4·053	1·311	
		LBTC	3·684	1·108	0·918
		HAR	4·368	0·761	
		LAR	3·316	1·204	3·217**
15.	This model gives a sense of participation to every child.	HBTC	4·421	0·902	
		LBTC	4·316	1·003	0·339
		HAR	4·632	0·831	
		LAR	4·526	0·772	0·409
16.	This model is not suited to the present day curriculum of the school.	HBTC	2·526	1·073	
		LBTC	2·684	1·057	0·457
		HAR	2·579	1·216	
		LAR	2·526	1·219	0·134
17.	It discourages rote learning.	HBTC	4·474	0·841	
		LBTC	4·158	1·018	1·046
		HAR	4·632	0·597	
		LAR	4·368	0·831	1·872
18.	The model trains the pupils to defer judgement.	HBTC	4·053	0·705	
		LBTC	3·368	0·761	2·878**
		HAR	3·053	0·911	
		LAR	3·947	0·911	0·357
19.	The model teaches the pupils to ask pin-pointed questions.	HBTC	4·737	0·733	
		LBTC	4·421	0·902	1·187
		HAR	4·842	0·375	
		LAR	4·316	0·895	2·380*

No.	*Items*	*Group*	*M*	*SD*	*t*
20.	Discipline in the classroom connot be maintained while using this model.	HBTC	3·421	1·216	
		LBTC	2·781	1·134	1·654
		HAR	3·105	1·286	
		LAR	3·526	1·268	1·014
21.	This model provides freedom to students for independent thinking.	HBTC	4·895	0·315	
		LBTC	4·684	0·749	1·13
		HAR	4·895	0·315	
		LAR	4·737	0·733	0·868
22.	Implementation of this model of teaching requires a change in the present system of examination.	HBTC	4·579	0·838	
		LBTC	4·579	0·692	0·0
		HAR	4·474	0·964	
		LAR	4·474	1·073	0·0
23.	This model requires insightful teachers.	HBTC	4·526	0·513	
		LBTC	4·105	0 658	2·216*
		HAR	3·420	0·769	
		LAR	3·263	0·452	·766

The analysed data indicated that the group low on Abstract Reasoning felt that it is difficult to analyse the thinking process of pupils, while teaching through this model. The group high on Theoretical Understanding and the group high on Abstract Reasoning were of the opinion that teaching through this model makes the pupils alert and attentive during the lesson. The group low on Theoretical Understanding and low on Abstract Reasoning felt that they were not competent to handle the various phases of the model. The group low on Theoretical Understanding felt that strict adherence to the rules of the model destroyed the pupils creative spirit. The group low on Abstract Reasoning were of the opinion that teaching through this model is time consuming and yet there is no thorow understanding of the subject-matter. The group high on Theoretical Understanding were of the opinion that the model trains the pupils to differ judgement. The group high on Abstract Reasoning were of the opinion that this model teaches the pupils to ask pin-pointed questions. The group high on Theoretical Understanding were of the opinion that this model requires insightful teachers. Lastly the groups did not differ on rest of the items.

(c) Willingness to Implement the Inquiry Training Model

Although theoretical understanding and reactions of the participants provide a lot of information regarding the feasibility of the Inquiry Training Model, it is necessary to know how willing the participants are to implement the model. If the teacher educators oriented in the model are not willing to implement the model in their respective teacher training colleges, it is not possible to train the pre-service graduate students in ITM. On the other hand if the teachers are not willing to implement the model in the actual classroom situation, the school pupil can never be trained in the scientific process skills. To find out to what extent the educators and the teachers are willing to implement this model, a few studies were conducted. In this section two studies, viz. willingness of teacher educators and willingness of a student-teachers are reported :

(i) Willingness of Teacher Educators to Implement the Model

To study the willingness of the teacher educators, to implement the Inquiry Training Model in the teacher education programme, Passi, Singh and Sansanwal (1985) administered a Willingness Scale developed by Passi and Sansanwal (1985). This scale was administered after training the teacher educators in the model. The data were analysed by computing percentages and using chi-square technique. The results are given in Table 10. The data in parenthesis are in percent.

The results presented in Table 10 indicate that all the chi-square values for all items are significant except for the last statement. Significant chi-square values show that the teacher

TABLE 10

S. No.	*Statements*	*Agree*	*Neutral*	*Disagree*	*Chi-square*
1.	The models of teaching are very difficult to implement.	9 (21·42)	5 (11·90)	28 (66·68)	21·63**
2.	My Head of Institution will give academic support for implementing models of teaching.	33 (78·58)	7 (16·66)	2 (4·76)	39·63**
3.	I don't understand the theory underlying the models.	5 (11·90)	3 (7·14)	34 (80·96)	43·06**
4.	My Head of Institution does not allow any change in the time table.	6 (14·28)	8 (19·04)	28 (66·68)	21·14**
5.	I am ready to implement provided my work load is reduced.	10 (23·80)	4 (9·52)	28 (66·68)	21·14**
6.	I have lost faith in educational innovations.	2 (4·76)	4 (9·52)	36 (85·72)	52·05**
7.	I am ready to implement provided I get additional increment.	2 (4·76)	3 (7·14)	37 (88·10)	56·77**

S. No.	*Statements*	*Agree*	*Neutral*	*Disagree*	*Chi-square*
8.	Models of teaching are more useful in those situations where hardware are available.	19 (45·24)	4 (9·52)	19 (45·24)	10·77**
9.	I don't have time for its' preparation.	5 (11·90)	4 (9·52)	33 (78·58)	38·17**
10.	The space facilities required for implementing Models of Teaching are not available in my institution.	10 (23·80)	0 (0)	32 (76·20)	23·34**
11.	The institutional materials for implementing Models of Teaching are not available in my institution.	10 (23·80)	5 (11·90)	27 (64·30)	19·06**
12.	Models of Teaching need not be applied as these may not improve teacher training programme.	4 (9·52)	10 (23·80)	28 (66·68)	22·34**
13.	Student-teachers of my institution will find it difficult to understand even the theoretical part of the model.	4 (9·52)	9 (21·42)	29 (69·06)	25·05**

S. No.	*Statements*	*Agree*	*Neutral*	*Disagree*	*Chi-square*
14.	The use of Models of Teaching in our teacher training institutions is not practicable.	4 (9·52)	7 (16·68)	31 (73·80)	31·34**
15.	Through this practice I could not develop abilities needed for implementation of Models of Teaching.	5 (11·90)	7 (16·68)	30 (71·42)	27·6**
16.	I am sure Models of Teaching can improve the quality of teacher training programme.	34 (80·96)	8 (19·04)	0 (0)	30·20**
17.	I can implement Models of Teaching inspite of all types of difficulties.	28 (66·68)	8 (19·04)	6 (14·28)	21·14**
18.	The implementation of Models of Teaching will not have any financial burden on my institution.	19 (45·24)	10 (23·80)	13 (30·96)	2·99**

** Significant at 0·01 level.

educators willingness is not distributed equally. On the basis of majority of responses falling under 'Agree' category for positive statement and 'Disagree' category for negative statements, Passi, Singh and Sansanwal (1985) concluded that the teacher educators were willing to implement the Inquiry Training Model,

(ii) Willingness of Student Teachers to Implement the Model

To study the willingness of the graduate student teachers to implement the Inquiry Training Model in the actual classroom situation, D'Lima and Sugandhi (1986) developed a willingness questionnaire and administered it to 76 graduate student-teachers after training them in the ITM. The data were analysed by computing percentages and using chi-square technique. The results are given in Table 11. The percentages are given in parenthesis.

TABLE 11

S. No.	*Statements*	*Yes*	*No*	*Undecided*	*Chi-square*
1.	Are you ready to use the model even if the college supervisor under whom you have to give the practice teaching lessons does not insist on it.	57 (73·68)	4 (5·29)	16 (21·05)	58·55**
2.	Will you continue to use this model even if your first inquiry lesson fails ?	46 (60·53)	8 (10·53)	22 (28·94)	29·17**
3.	Will you use this model even if it is not compulsory to do so ?	31 (40·79)	15 (19·74)	30 (39·47)	6·34**
4.	Will you continue to use this model when you become a regular teacher.	46 (60·53)	2 (2·63)	28 (36·84)	38·63**

S. No.	*Statement*	*Yes*	*No*	*Undecided*	*Chi-square*
5.	Are you willing to use ITM, inspite of all difficulties and inconvenience ?	54 (71·05)	10 (13·16)	12 (15·79)	48·74**
6.	Are you willing to attend another workshop on ITM ?	68 (89·47)	6 (7·89)	2 (2·64)	108·08**
7.	Would you like to learn other models of teaching ?	64 (84·21)	5 (6·58)	7 (9·21)	88·61**
8.	We wish to select student teachers interested in ITM for further training so that they can help us in conducting future workshops. Are you willing to join this programme ?	56 (73·68)	10 (13·16)	10 (13·16)	55· 7**
9.	Would you encourage regular teachers in schools to undergo training in the ITM.	66 (86·84)	3 (3·95)	7 (9·21)	98·25**

** Significant at 0·01 level.

Based on the results presented in Table 11, it was concluded that the graduate student teachers trained in ITM were willing to use the model even when it was not made compulsory. They also showed a desire to undergo further training in the model and act as resource persons. All chi-square values are significant. This indicates that subjects responses falling under yes, no and undecided categories differ significantly. Favourable reactions of majority of students indicate that they were ready to implement ITM in Schools.

CONCLUSIONS

Studies conducted in the area of theoretical understanding of ITM, Reaction towards ITM, and the willingness to implement ITM suggest the following regarding the feasibility of the Inquiry Training Model.

1. Theoretical Understanding

(a) Training provided in ITM, through theory cum demonstration does bring about high understanding in the theoretical aspects of the model.

(b) Although the study conducted (1985) on student teachers indicated that the group high on Abstract Reasoning had significantly higher Mean Score on Theoretical Understanding as compared to the group low on Abstract Reasoning yet another study conducted (1986) did not indicate this.

2. Reactions Towards the Model

(a) On the whole the studies indicate that the reactions towards the model of teacher educators as well as of student teachers are highly favourable.

(b) The study conducted on teacher educators (1985) did not show significant difference between the reactions of High Achievers and Low Achievers on Theoretical Understanding of the Inquiry Training Model.

(c) The studies conducted on student teachers (1985-1986) indicate that the groups high on Abstract Reasoning and

Theoretical Understanding on the whole showed more favourable reactions towards the model as compared to the groups Low on Theoretical Understanding and Low on Abstract Reasoning.

3. Willingness to Implement the Model

(a) The study conducted in 1985 showed high willingness on the part of the teacher educators to include ITM in the teacher education programme. The study conducted in 1986 showed that the student teachers were willing to use the model in the actual classroom situation.

In conclusion it can be said that Theoretical Understanding of the model through theory cum demonstration and the introduction of the model in the actual classroom situation were not difficult.

However, the observation and the practical experience of the researchers in the area of Inquiry Training Model of Teaching suggests that the participants high on Abstract Reasoning and Theoretical Understanding display better skills in the use of the Model. Therefore, more studies in the area of the model are required especially to find out whether the teachers are capable of guiding the pupils to build the theories at four different levels and analyse the thinking process of the pupils. Further it is essential to know what level of intelligence and personality traits are needed to be an effective teacher of ITM.

4

Inquiry Training Model In Action

C. G. D'LIMA
SUGANDHI R. PRABHU
JESSIE MARTIS

INTRODUCTION

This chapter is particularly written for the beginners who wishes to train themselves in the practical skills of Inquiry Training Model. It is very important to the beginning teacher to visualize in advance what is going to happen during the Inquiry Training Process. Therefore it is advisable to plan the lessons. While planning the lesson the teacher should keep in mind what are the behavioural objectives he is going to achieve through this model. What opening moves she will use for each phase of the model for the following :

—Inquiry procedure and encounter with the problem.
—Data gathering : verification
—Data gathering : experimentation
—Formulating an explanation
—Analysis of the Inquiry Process

To enable the teacher to understand the actual process of Inquiry Training in the classroom, the following lesson plans are presented :

(A) 1. A lesson plan in Geography : Equatorial Region
    2. A Transcript (actual recording of a lesson that has taken place)
    3. A worksheet prepared by one of the students during the lesson

(B) 1. A lesson plan in Geography : Ocean Currents
    2. A Transcript (actual recording of a lesson that has taken place)
    3. A worksheet prepared by one of the students during the lesson

(C) 1. A lesson plan in Science : Properties of Sodium
    2. A Transcript

3. A worksheet prepared by one of the students during the lesson

(D) 1. A lesson plan in Science : Buoyancy of water
2. A Transcript
3. A worksheet prepared by one of the students during the lesson

LESSON PLAN FORMAT (LPF) FOR ITM

Name : Sugandhi R. Prabhu
Date : 6-4-86
Institution : H. J. College of Edn.
Class : Std. VIII
Subject : Geography
Topic : The Regions of The Word—The Equatorial Region
Lesson No. 1

Educational (Behavioural) objectives :

1. To develop in the students the skill of asking data gathering verification and experimentation questions.
2. To develop scientific inquiry skills in the students.
3. To make the pupils understand the physical features of the Amazon river basin and the reasons for thin population in that region.

PHASE I

Explanation of Inquiry Procedure and Encounter with the Problem :

(a) Generating Opening Moves to Initiate The First Phase of the Model.

"We are going to play a new game today. Everyone should participate in this game. I will present a puzzling situation and you will solve the puzzle following the rules of the game."

(b) Explanation of the Inquiry Procedure.

"Here are the rules of the game. It will present a problem to you and you will ask questions to gather more information about the problem. The questions that you ask should be framed in such a way that my answer to them has to be either 'Yes' or 'No'.

When you have gathered enough data you should make guesses regarding the solutions and then ask questions to test these guesses—Thus you have to find out the solution to the problem."

(c) Encounter With The Problem : Discrepant Event.

The river basins of the world viz. the Nile, the Indus, the Huang-Ho were the cradles of great civilizations. Today the basins of rivers like the Ganges, Yamuna, Volga, Danube, St. Lawrence are thickly populated. 'Amazon' in South America is the longest river in the world and has a fertile basin but it is undeveloped and has very thin population.

(d) Discrepancy Accounted For.

Inspite of being the largest and the most fertile river basin why is the Amazon region undeveloped ?

PHASE II

Data Gathering : Verification.

(a) Generating Opening Moves to Initiate the Second Phase of the Model.

"To find out further information, you may now begin the inquiry through questions which would elicit the answers 'Yes' or 'No'. You may ask questions to tap more information on the object, the events connected, the conditions and properties of the object."

Object :

(1) Is the Amazon basin very hot ?
(2) Is it the only river in that region ?

Event :

(1) Do the natives prevent of other countries from coming to that place ?

(2) Is there any evidence of the occurrence of cyclones in that region ?

Conditions :

(1) Does the river dry in summer ?

(2) Was that place thickly populated any time in history ?

Property :

(1) Does that region have rainfall more than 200 c.m. on an average throughout the year ?

(2) Is that place covered with trees ?

PHASE III

Data Gathering : Experimentation :

(a) Generating Opening Moves to Initiate the Third Phase of the Model.

'Now you have gathered enough information and you might have formed some hypotheses in your mind. You may test the hypotheses by asking experimental questions. The question that you ask should have the 'if' clause and the answer to it has to be either 'Yes' or 'No'.

Object :

(1) If there were no trees in that region would man live there ?

(2) If the natives of that place were educated and were introduced to the developed countries would that place develop ?

Condition :

(1) If there are seasonal changes in that region during the year, will that place be thickly populated ?

Property :

(1) If the heat of that place was reduced using coolers and airconditioned, would man be able to live there ?

PHASE IV

Formulating an Explanation :

(a) Generating Opening Moves to Initiate the Fourth Phase of the Model.

"You have verified and tested your hypothesis. Would you explain the situation by formulating theory ?

(b) Probable Theories.

(1) The place is very hot throughout the year so man cannot live there.

(2) The place is full of forests, so man cannot have any profitable occupation except lumbering hence it is not thickly populated.

(c) Developing the theory.

(1) *Simple Linear Causations* :

The thick growth of forest in the Amazon basin is unsuitable for human inhabitation.

(2) *Theories of Properties* :

The intense heat and heavy rainfall in the Amazon basin leads to the quick growth of trees which cannot be stopped.

(3) *Analogies* :

The influence of bad company on one's character may be so intense and deep rooted that it is difficult to mould the person.

(4) *Application of Generalization* :

Human beings find it difficult to live in areas which have intense heat and heavy rainfall inspite of having fertile soil because such a climate leads to the quick growth of trees and forests which cannot be stopped.

PHASE V

(a) Generating Opening Moves to Initiate the Fifth Phase of the model.

Let us review the steps of inquiry and analyse the Inquiry Procedures.

(b) Recapitulation of the Steps of Inquiry.

- (i) Understanding the problem.
- (ii) Asking fact finding questions.
- (iii) Asking experimentation questions—questions to test the hypothesis.
- (iv) Formulating an explanation.

(c) Discussion of the Elements of Inquiry.

- (i) Why did you ask questions related to :—
  - —Seasons of the Amazon region.
  - —The Soil erosion in that region etc.

TRANSCRIPT OF LESSON 1

Tr. We are going to play a game today. I will tell you the procedure of the game. Listen carefully.

I will present a problem to you. It is a puzzling problem. You cannot solve the problem haphazardly. To be on the right track you have to follow the rules of the game. Before solving the problem you have to find out the facts pertaining to the problem. And to find out the facts you have to ask a series of questions. But remember one thing, the questions that you ask have to be framed in such a way that my answer to them has to be just 'yes' or 'no'. If your questions do not elicit either 'yes' or 'no' answer I will ask you to rephrase them. If the question is too general I will ask you to be more specific. Is this clear to all ?

PHASE I
Explanation of the Inquiry procedure.

P's. Yes.

Tr. After I present the problem what have you to do ?

P 1 We have to find out the facts pertaining to the problem.

Tr. And how should you gather these facts ?

P 2 By asking questions which elicit the 'yes' or 'no' response.

Tr. Well, here is the puzzling problem, be alert and listen.

The Teacher ensures that the pupils have understood the rules of the game.

'You have learnt that the river basins of the world viz. the Indus, the Nile, the Hwang-ho were the cradles of great civilizations. Today the basins of rivers like the Ganges, Yamuna, St. Lawrence, Danube are thickly populated. 'Amazon' in South America is the longest river in the world and has a fertile basin. Yet it is undeveloped.

Is the problem clear to you ?

Encounter with the problem. The Teacher presents the discrepant event.

P's Yes.

Tr. To collect further informations you may ask questions which elicit 'yes' or 'no' response.

P 3 Can we ask questions regarding what happened in the past ?

Tr. Certainly. You may gather information from various angles. You may ask questions about the river, about the conditions of that place, the properties of the place, and even about the events pertaining to the object.

P 4 So we have to probe deep into the matter.

Tr. Exactly. What is the puzzle or discrepancy that you note in this problem ?

The pupils note the discrep ancy.

P 1 Inspite of having a fertile land, Amazon basin is still undeveloped why ?

Tr. You are right. Now start asking the questions. Let me see, who will begin ?

P 1	Is 'Amazon' the only river in that region ?	PHASE I **Data Gathering Verification** The pupils ask fact finding questions
Tr.	Yes.	
P 2	Has it many tributeries ?	
Tr.	Yes.	
P 2	Has that place any poisonous creatures ?	
Tr.	Yes.	
P 5	Are there many wild animals ?	
Tr.	Yes.	
P 4	Is that area covered with ice ?	
Tr.	No.	
P 4	Then, is it very cold ?	
Tr.	No.	
P 2	Is it very dark ?	
Tr.	Be specific. What do you mean by dark and what is dark ?	
P 2	I mean, does that place get any sunlight ?	
Tr.	Yes.	
P 3	Does the river dry often ?	The Teacher asks the pupils to be specific.
Tr.	No.	
P 3	Is it not ?	
Tr.	What does it refer to ?	
P 4	Is the climate very hot ?	The pupil is finding data regarding the event
Tr.	Yes.	
P 5	Is the temperature more than that of our place ?	
Tr.	Yes.	
	(There are no questions for a short while)	
Tr.	Take a quick glance at the questions that you have asked and try to put together the data gathered so far. You may then continue to ask as many questions as you want.	The Teacher helps the pupils to summarise the facts collected.
P 4	Is the place inhabited by the natives ?	
Tr.	Yes.	
P 3	Are the natives living there in large numbers ?	
Tr.	No, not many.	
P 3	Was it thickly populated any time in history ?	

Tr. No, what do you have in mind ? (No response).

P 2 Is there good transport facility ?

Tr. No.

P 2 Why didn't the people of other countries like the UK and the USA try to develop this region ?

The pupil is collecting data regarding the condition.

Tr. This question does not elicit 'yes' or 'no' answer. So you have to rephrase your question.

P 1 Well, I will try......Did the USA make an attempt to develop this region ?

The Teacher reminds the pupil to follow the rules of the game.

Tr. No.

Here is the map of the world you can study it, gather some more details through the map, or verify the data already gathered.

P 3 (Pointing to the equator) Is this latitude which passes above the Amazon river, the equator ?

Tr. Yes. This is a good observation.

P 3 Do all the places located in the equatorial region have extremely high temperature ?

Tr. Yes.

P 3 I got the answer to the solution.

Tr. But wait. You might have arrived at some explanation. First you should test your guess. You may ask questions beginning with 'if', and my answer to them has to be 'yes' or 'no'.

P 3 All right......If we provide coolers and air conditioners to that place will people begin to live there in large numbers ?

The Teacher asks the pupils to test their hypothesis with the help of experimentation questions.

Tr. No.

P 3 But the place is very hot because the sun rays fall directly on that place so if we use coolers and airconditioners we should be able to have a comfortable life there. This is the explanation I give.

Tr.	We have an explanation here, to the puzzle I presented to you. Let us critically analyse and find out if that explanation is right.	The Teacher asks the pupils to analyse the probable theory.
P 4	If high temperature was the only drawback of the place, the countries which have far advanced technology would have occupied that place with coolers and airconditioners. The very fact that this place has not developed tells us that the reason is some thing else.	
Tr.	Anybody else would like to react ?	
P 3	I want to test my guess. If the position of the sun changes and the sunrays fall directly on India instead of falling on the Amazon region, will human inhabitation increase in that region ?	The pupil is isolating the variable.
Tr.	Yes.	
P 3	Is there enough rainfall in that area ?	
Tr.	Yes.	
P 1	Does that region have seasons as we have ?	
Tr.	No.	
P 2	Is the atmosphere filled with poisonous gas ?	
Tr.	No.	
P 3	Is that place covered with forests ?	
Tr.	Yes.	
P 1	Are the trees poisonous ?	The pupils is trying to collect data regarding the property.
Tr.	No.	
P 3	If we cut down the trees, is cultivation possible ?	
Tr.	No.	
P. 4	Is it because of soil erosion ?	
Tr.	Yes.	
P. 3	If the same place was in England without much heat and rainfall would it have been developed ?	The Teacher tells the pupil to rephrase the question
Tr.	Yes.	
P 5	What occupation can man have in that place ?	The pupil is theorising.

Tr.	No, your question is not a pointed one. Please rephrase it.	
P 5	I think since there are forests, lumbering is the only occupation and it is not a good occupation so man does not live in this region.	
P 4	I do not agree to this because, lumbering is a profitable occupation and if lumbering was possible this region would have been a colony of the advanced country.	
P 3	Is it possible to cut down all the forests and clear the place ?	
Tr.	No.	
P 5	If we cut down the trees and at the same time prevent soil erosion, is cultivation possible in that area ?	The Teacher helps the pupil to develop the theory. (Simple linear Causation).
Tr.	Yes, it is possible, what makes you say so ? Do you have anything in mind ?	
P 5	Let me try. The Amazon basin falls in the equatorial region. And because of the heat and rainfall and the thick forests human inhabitation is difficult.	
Tr.	Well done. You have carefully put together the data and have formed a theory. Would any one like to react to it, or improve on it ?	
P 5	I would put it this way. I think the soil is so fertile that it facilitates the growth of trees. And even if we try to cut down the trees, the rainfall and the intense heat lead to the quick growth of the trees in this region. Am I right ?	Theories of Properties.
Tr.	You put it in a better form and you are perfectly right. I can give you an example to understand the situation in the Amazon basin better. The influence of bad company on his character may be so intense and deep rooted that it is difficult to would the	The Teacher provides an analogy.

	person. Now let me see if any one can apply the theory to other situations.	
P.	Human beings find it difficult to live in areas which have intense heat and heavy rainfall inspite of having fertile soil because such climate leads to the quick growth of trees and forests which cannot be stopped.	Application of generalization.
Tr.	"Let us reflect over the questions we asked and identify the steps of inquiry that we used to find out the reason for the puzzle." What did we do first ?	PHASE V The Teacher analyses the inquiry process.
P.	You narrated the situation in the Amazon basin and we stated the puzzle.	Recapitulation of the stages.
Tr.	Then……… ?	
P.	In order to know more about what had happened in the Amazon basin, we asked question.	
Tr.	What type of questions did you ask ?	
P.	We asked the questions which elicited Yes/No response.	
Tr.	Alright. Did these questions help you in any way ?	
P.	Yes, they did. They helped us to form some guess in our mind.	
Tr.	Which questions helped you to be on the right path ?	
P.	The question that whether there are forests and whether there is rain, made us think that the place is covered with thick forests.	The Teacher analyses the questions of the pupils.
P.	And the 'Yes' answer to these questions made me think of soil erosion.	
P.	We could think of various aspects because you had told us to probe into the place, events and conditions of the place.	

Tr. Right. So, at first you encountered a problem which had a puzzle. You asked questions and collected more information, tested the information and finally arrived at the conclusion.

A nice thing I noted today is that every one in the class made an attempt to take part in the inquiry process.

P. That's really nice !

LESSON PLAN FORMAT (LPF) FOR ITM

Name : Sugandhi R. Prabhu	Date : 15-6-86
Institution : H. J. College of Edn.	Class : Std. IX
Subject : Geography	Topic : The Influence of the Ocean Currents
Lesson No. 1	

Educational (Behavioural) Objectives

1. To develop in the students the skill of asking data gathering verification and experimentation questions.
2. To develop scientific inquiry skills in the students.
3. To make the pupils understand that the Ocean Currents influence the climate of a place.

PHASE I

Explanation of the Inquiry Procedure and Encounter with the Problem :

(a) Generating Opening Moves to Initiate the First Phase of the Model.

'Here is a game for you to play. It is called the inquiry process. Everyone can participate in it. At first I will give you a puzzling situation and according to the rules of the game you have to solve the puzzle.

WORK—SHEET (ITM)

Medium : English
Date : 6-4-86
Name of the pupil : M. L. Roll No. : 28 Class : VIII Subject : Geography
Institution : St. Mary's High School Topic : Regions of the World. The Equatorial Region. Name of the teacher : Sugandhi R. Prabhu

Sr. No.	*Data Gathering Verification Questions*	*Teacher's Response*	*Sr. No.*	*Data Gathering Experimentation Questions*	*Teacher's Response*	*Theory and Reason*
1.	Is Amazon the only river in that region.	Yes	1	If we cut down all the trees and present soil erosion us it possible to develop the place ?	Yes	1. Because of the thick forests and the wild animals man can not live there.
2.	Does the river dry often ?	No				
3.	Was it thickly populated any time.	No				

(Contd.)

4.	Is the temperature of that place more than that of our country ?	Yes	2	If we use airconditions and coolers can man live there ?	Yes	2. Because of soil erosion cultivation is not possible. Hence it is unsuitable for human inhabitance.
5.	Are there many mountains ?	No				
6.	Is that place covered with forests ?	Yes				
7.	Is there soil erosion ?	Yes				
8.	Are the trees poisonous ?	No				
9.	Does the place get a lot of rainfall.	Yes				

Formal Statement of theory······ ··············

The intense heat and heavy rainfall in the Amazon basin leads to the quick growth of trees which cannot be stopped.

(b) Explanation of the Inquiry Procedure.

"Here are the rules of the game. I will present a problem to you. To solve this problem you have to collect more information about the problem. To collect the information, you should ask questions which will elicit the response 'yes' or 'no'. When you have gathered enough information and have formed a hypothesis in your mind you can ask experimentation questions to test your hypothesis. Thus you have to find a solution to the puzzling event.

(c) Encounter with the Problem : Discrepant Event.

William Smith was a resident of New Castle. He was born and brought up in that place. In his late thirties, he was transferred to a place called Silloth. Smith had experienced severe winters in New Castle and expected the same in Silloth. This is because, both the places, namely, New Castle and Silloth are located in the same temperate zone. But to his surprise, he found that Silloth was warm instead of cold in winter.

(d) Discrepancy Accounted For.

Inspite of being in the same zone, why is Silloth warm in winter while New Castle is extremely cold ?

PHASE II

Data Gathering : Verification.

(a) Generating Opening Moves to Initiate the Second Phase of the Model.

To find out further details about the puzzling event, you may ask questions which will elicit either 'Yes' or 'No' response. Ask such questions which will help you to explore the events, conditions and the properties of the objects in the discrepant event.

Object :

(1) Are both the places, New Castle and Silloth, located on the same latitude ?

(2) Is Silloth located at an altitude ?

Event :

(1) Do all the places on the North-West coast of England have warm winters ?

(2) Does Silloth get warm breez ?

Conditions :

(1) Does the weather of Silloth turn extremely hot in summer ?

(2) Does the temperature of the sea breez affect the coastal areas in winter ?

Properties :

(1) Is Silloth prone to volcanic erruption ?
(2) Has Silloth desert vegetation ?

PHASE III

Data Gathering Experimentation

(a) Generating Opening Moves to Initiate the Third Phase of the Model.

If you feel that you have enough information at hand, you may ask experimentation questions and test the hypothesis that you might have formed.

Object :

If there was no sea between England and Irland, would, Silloth be warm in winter.

Event :

If the water of the sea on the Eastern Coast was artificially warmed, would New Castle be warm as Silloth.

Conditions :

If there was no rainfall throughout the year, would Silloth be warm in winter ?

Properties :

If Silloth had no desert vegetation, would it be warm in winter ?

PHASE IV

Formulating an Explanation :

(a) Generating Opening Moves to Initiate the Fourth Phase of the Model.

If you have tested your guess and if you have arrived at the right explanation you may word it in the form of a theory.

(b) Probable Theories.

(1) The food habits of William Smith underwent a change when he shifted from New Castel to Silloth. The biological changes which took place in William Smith as a result of this made him feel warm in winter at Silloth.

(2) As William Smith was suffering from fever when he shifted to Silloth, he found the winters warm.

(c) Developing the Theory :

(1) *Simple Linear Causation :*

The Ocean currents affected the climate of Silloth.

(2) *Theories of Properties :*

The Gulf steam warm current carries a lot of heat from the tropics towards North England. The heat of the current affects the sea breeze which blows on land and helps in keeping the cool winters of Silloth warm.

(3) *Analogies.:*

A fight in the neighbourhood affects the peace of a family.

(4) *Application of Generalization :*

The Ocean currents which flow from the Equator towards the poles, carry a lot of heat. This heat helps to keep the cold regions of the North and South Temperate zones warm in winter.

PHASE V

(a) Generating Opening Moves to Initiate the Fifth Phase of the Model.

Let us review the steps of inquiry and analyse the Inquiry Procedures.

(b) Recapitulation of the Steps of Inquiry.

(i) Understanding the problem.
(ii) Asking fact finding questions.
(iii) Asking experimentation questions—questions to test the hypothesis.
(iv) Formulating an explanation.

(c) Discussion of the Elements of Enquiry

—Why did you ask questions related to
—The population of New Castle
—Mountains in Silloth
—Volcanic erruption in Silloth etc……

TRANSCRIPT OF THE LESSON II

Name : Sugandhi R. Prabhu
Institution : H. J. College of Edn.
Subject : Geography
Date : 15-6-1986
Class : Std. IX
Topic : The Influence of the Ocean Currents

Tr. Here is a game for you to play. It is called the inquiry process. Everyone should participate in it. At first I will give you a puzzling situation and according to the rules of the game you should solve the puzzle.

PHASE I

The Teacher uses the opening move to initiate the first phase of the model.

Here are the rules of the game. I will present a problem to you. To solve this problem you have to collect more information about the problem. This has to be done by asking questions which will elicit either 'Yes' or 'No' answers. If your question can not be answered 'Yes' or 'No', I will ask you to rephrase your question.

The Teacher explains the rules of inquiry procedure.

When you have gathered enough information and have formed a hypothesis in your mind you may ask experimentation questions to test your hypothesis. The experimentation questions should have the 'if' or 'Suppose' clause and should elicit either 'Yes' or 'No' response. Then you have to find a solution to the problem. Are the rules of the game clear to all ?

P 1. Does it mean that we should not ask 'What', 'Why' and 'When' questions ?

Tr. That is right. Your questions should help you to gather information only through 'Yes' or 'No' answers. If your question is too general I will ask you to make it specific. Will anyone give an example for a specific and general question ?

P 2. A general question may be 'Are the flowers in the pot colourful ?' and the specific question is "Are the roses in the pot red ?"

Tr. Yes. Is this clear to all ? Now listen to the puzzling event.

William Smith an Englishman was a resident of Newcastle. He was born and brought up there. In his late thirties he was transferred to a place called Silloth. Both these

Encounter with the discrepant event.

The Teacher presents the discrepant event.

places are located in the North temperate zone. William Smith had experienced severe winters in Newcastle and he knews that the place used to get frozen in winter. He expected extremely cold winters in Silloth. But to his surprise he found that Silloth was warm in winter.

Tr. Is the discrepant event clear to all ?
Ps. Yes.
Tr. Where was William Smith living ?
Ps. He was living in New Castle ?
Tr. How was the climate in New castle.
P. Newcastle was very cold in Winter.
Tr. How was the climate in Silloth ?
P. It was warm in Winter.

The teacher ensures that the pupils have understood the discrepant event.

Tr. Why did Smith think that Silloth would be extremely cold in winter ?
P. Both Silloth and Newcastle are located in the cold temperate zone. Hence he thought that both the places would have the same climate.
Tr. What is the discrepancy you note in this problem ?
P. Inspite of being located in the same temperate zone, why is Silloth warm in winter when Newcastle is extremely cold ?

The pupils note the discrepancy in the event.

PHASE II

Tr. Let us then proceed. Ask fact finding questions first.
P 1. Is Newcastle close the Silloth ?
Tr. What does close indicate ? Can you rephrase the question ?
P 2. Is the distance between Newcastle and Silloth more than 100 Kilometers ?
Tr. Yes.

The pupils ask fact finding questions. The teacher asks the pupils to rephrase the question.

P.	Is Silloth located at a high altitude than Newcastle ?	
Tr.	No.	
P.	Is Silloth a desert area ?	
Tr.	No.	
P.	Are there many people living in Silloth ?	The teacher asks the pupil to rephrase the question.
Tr.	Make your question pointed.	
P.	Is the population of Silloth more than that of Newcastle ?	
Tr.	Yes. Why do you ask this question ?	
P.	I have observed that towns which are crowded have more warmth than other places.	
Tr.	Alright. Continue to collect some more information.	
P.	Are the two places on the two longitude ?	
Tr.	No.	
P.	Are they on the same latitude ?	The pupils collect the data regarding the object.
Tr.	No.	
P.	Are they on the same latitude ?	
Tr.	Here in the map you may come and verify yourself.	
P.	Is the vegetation of Silloth same as that of Newcastle ?	
Tr.	No.	
P.	Are Silloth and Newcastle both coastal places ?	
Tr.	Refer to the map. . . .Are they on the sea coast ? . . .Yes.	
P.	Is Silloth below the sea level ?	
Tr.	No.	
P.	Did William Smith know the climate difference in both the places before he went to Silloth ?	
Tr.	No.	

P.	Was there any change in his food habits?	
Tr.	Yes.	
P.	Did he put on weight after he went to Silloth ?	
Tr.	No.	
P.	Was there any change in his biological constitution ?	
Tr.	Are you trying to theorise ? If you have any guess try to test it experimentally.	PHASE III The teacher invites the pupil to test their hypothesis.
P.	If there was no constitutional change in Smith, would he still feel warm ?	
Tr.	Yes.	
P.	Do all the people in Silloth feel warm in winter ?	
Tr.	Yes.	
P.	So it is not just William who felt warm in winter ?	
Tr.	No. What guess did you have in mind ?	
P.	I thought the change in the food habits of Smith made him fall sick and so he felt warm in winter.	The pupils hypothesis.
P.	Are the ports of Silloth frozen in winter ?	
Tr.	No.	
P.	If Silloth was a plateau would it be still warm in winter ?	The pupil is testing the hypothesis with an experimentation question.
Tr.	No.	
P.	Is there rainfall in Silloth ?	
Tr.	Yes.	
P.	Does it rain in Newcastle ?	
Tr.	Yes.	
P.	Are the trees in Newcastle tall ?	

Tr.	What do you mean by tall ? Be specific.	The teacher asks the pupil to be specific.
P.	O.K. I'll change my question. Is there desert Vegetation in Silloth ?	
Tr.	No.	
P.	Is there a great difference in the temperature of both the places ?	
Tr.	Be specific.	
P.	Is there any difference in the temperature ?	The teacher asks the pupils to be specific.
Tr.	Be specific.	
P.	Is the difference in temperature more than 10° C ?	
Tr.	Yes. (There is a long pause and the pupils are thinking).	
Tr.	Let us go back to the questions asked and summarise the facts we collected. Who will do it ?	
P.	Both the places are on the same latitude, both are coastal areas, the difference in the temperature is more than 10°C. All the people in Silloth feel warm in winter, the vegetation in Silloth is different from that of Newcastle.	The teacher helps the pupils to summarise the facts collected.
P.	Do the animals in Silloth feel warm in winter ?	
Tr.	Yes. You can form groups of three or four and exchange ideas.	The teacher encourages group discussion.
P.	Does the Irish sea turn warm in winter ?	
Tr.	Yes, it does.	
P.	Do all the places in the North West coast of England have warm winters ?	
Tr.	Yes.	
P.	Was there a volcanic erruption in Silloth anytime ?	The pupils is collecting data regarding the event,
Tr.	No,	

P.	Was there any nuclear bomb explosion near Silloth when Smith went there ?	
Tr.	No. I don't think so.	
P.	If there was no Irish sea between England and Ireland would Silloth be still warm ?	The pupil is isolating the variable.
Tr.	No. I would like you to go back to the information you have collected and ask some experimental questions.	
P.	Is the water of Irish sea warm in winter ?	
Tr.	Yes	
P.	Is it very warm ?	
Tr.	Yes. Have you guess ?	
P.	If the sea water was frozen in winter, would Silloth be still warm in winter ?	The pupil is testing the hypothesis.
Tr.	No.	
P.	Do Both the places get the same amount of sunlight ?	
Tr.	Yes.	
P.	I think that the sea water of Silloth is warm and this affects the climate of Silloth and makes its winters warm.	PHASE IV The pupil is theorising.
Tr.	Would anyone like to react to this ?	
P.	When both the places are near the sea, and are located on the same latitude why should only the Irish sea be warm ?	
Tr.	Well, your argument is good. Probe deeper.	The teacher motivates the pupils to probe further.
P.	Has Silloth warm and wet breeze ?	
Tr.	Yes.	
P.	Can water carry heat from one place to another ?	
Tr.	Yes.	
P.	How far can it take it ?	

Tr.	No, rephrase your question.	The pupil is testing his theory.
P.	If the sea near Newcastle was made warm artificially would its winters be warm ?	
Tr.	Yes, of course.	
P.	I think the sea water around Silloth retains the warmth of summer upto winter and as a result the sea breeze which blows over the land in winter is warm and keeps the winter on the North West coast of England warm.	PHASE V (Simple linear causation)
Tr.	But your theory is not complete. What makes the sea water warm ?	The teacher helps the pupils to develop the theory.
P.	Is it possible for the heat from the equatorial region to reach the sea near Silloth ?	
Tr.	Yes. Probe deeper.	
P.	The ocean currents which come from the equatorial region keep the sea warm in winter and this helps to keep the winters in Silloth warm.	(Theories of properties).
Tr.	Can anyone build on this ?	
P.	The ocean currents in this Western coast of England carry a lot of heat from the equatorial region and this influences the climate of Silloth.	
Tr.	Yes, that is right. We know that a fight in the neighbourhood can affect the peace of a family living there. Similarly the warm ocean currents of the Atlantic ocean affects the climate of the places in the North Western coast of England. Can you give me an analogy or an example to explain this ?	The teacher provides an analogy.
P.	Ones personality is affected by the company he has. The bad company has bad influence on the person.	The pupils give an analogy.

Tr. Yes, and good company has good influence on ones character.

So today we have learnt that the ocean currents affect the climate of a place. The warm currents which flowing from the equatorial region to the polar regions affect the cold winters of the places on the sea coast and give them a warm winter.

Application of generalization.

We arrived at a solution to the problem. Now let us review the process we followed to arrive at the right solution. What did we do first ?

PHASE VI
Analysis of the process of inquiry.

P. You presented a problem and we found out the discrepancy in that problem.

Recapitulation of the steps.

Tr. Then what did we do ?

P. We asked fact finding questions which could be answered 'Yes' or 'No' by you.

Tr. What did you do when you had a guess ?

P. We tested it with experimentation question beginning with 'if'.

Tr. How did you arrive at the final conclusion ?

P. We put the facts together one by one and gradually developed the theory.

Tr. You also gave me an analogy to show the influence of ocean currents. was the problem puzzling ? Did it make you think ?

P. Yes indeed.

Tr. Which questions helped you to arrive at the solution ?

P. Questions like 'Is the Irish sea is always warm ?' Do all the people experience warm winters in Silloth ?, helped me to think about the influence of sea waters.

The teacher helps the pupils to analyse the questions.

P. My question whether sea water can retain it's warmth for a long time and whether heat is carried by water made me think of the ocean currents of the equatorial region.

Tr. Could you have avoided some questions ?

P. Yes, the question about the trees in Newcastle was not needed.

Tr. Did you like this game ?

P. Yes.

Tr. Did you like asking pointed questions ?

P. It was difficult in the beginning. Some of us forgot to phrase the questions correctly.

Tr. Do you think this method is effective to learn new things ?

P. Yes, and what we learnt today will always be remembered.

LESSON PLAN FORMAT (LPF) FOR ITM

Name : Ms. Jessie Martis	Date : 3-7-86
Institution : Canossa H. School	Class : X
Subject : Chemistry Lesson No. 1	Topic : A case of failure of electrolysis of a salt solution.

Educational (Behavioural) Objectives

1. To develop skill in asking verification questions.
2. To develop scientific thinking.

PHASE I

Explanation of Inquiry Procedure and Encounter with the Problem.

(a) Generating Opening Moves to Initiate the First Phase of The Model :

Let us play a game called the Inquiry Process. Everyone can participate in this game. I will give you a puzzling situation. You have to solve the puzzle by asking questions.

(b) Explanation of the Inquiry Procedure

First I will present the problem, then you will start asking questions to gather more information about the problem. You should frame the questions in such a way so as to induce 'yes' or 'no' answers from me. When you have gathered enough information you should make assumptions regarding the solution, and then ask questions to test these assumptions. In this manner you should try to find out the solution to the problem.

(c) Encounter with the problem : Discrepant Event

A laboratory assistant working for a professor used to prepare the needed metals for the experiments by using the method of electrolysis. For example, when he needed Magnesium, he would prepare a solution of Magnesium Chloride in water and obtain Magnesium metal by performing electrolysis. In this way he used to obtain Silver from Silver Nitrate, copper from Copper sulphate, etc. One day, the Professor was in need of some sodium. The assistant tried to get Sodium from Sodium Chloride solution, through the method of electrolysis. But, to his surprise, he could not get any sodium metal.

(d) Discrepancy Accounted for

Electrolysis is used to obtain metals from the solutions of metal salts. However, when the laboratory assistant tried to obtain sodium from sodium chloride solution through electrolysis, the experiment failed, Why ?

PHASE II

DATA GATHERING : VERIFICATION

(a) Generating Opening Moves to Initiate the Second Phase of the Model.

To find out further information about the problem, ask questions which can be answered by me, in 'yes' or 'no'. Ask

WORK-SHEET (ITM)

Medium : English
Date : 15-6-86
Name of the pupil : R. D. Roll No. 23 Class IX B Subject : Geography
Institution : St. Mary's High School Topic : The influence of the ocean currents. Name of the teacher : Sugandhi R. Prabhu.

Sr. No	*Data Gathering Verification Questions*	*Teacher's Response*	*Sr. No.*	*Data Gathering Experimentation Questions*	*Teacher's Response*	*Theory and Reason*
1.	Were the summers in Silloth cold ?	No	1.	If William Smith had gone to a nothern place on the western coast of England would he have found the winters warm ?	Yes	The sea water of Silloth in warm, therefore Silloth has warm winters.
2.	Was the temperature in Silloth more than 20°C in winter ?	No				
3.	Do both the places fall on the same longitude ?	No				
4.	Are they on the same latitude ?	Yes				
5.	Did the other people in Silloth find the winters warm ?	Yes	2.	If there was no Irish sea between England and Ireland world.		
6.	Is the vegetation in both the places the same ?	No				

(Contd.)

Sr. No.	Data Gathering Verification Questions	Teacher's Response	Sr. No.	Data Gathering Experimentation Questions	Teacher's Response	Theory and Reason
7.	Was there any neuclear bomb explosion ?	No		Silloth be still warm ?	No	
8.	Is the water of Irish sea warm ?	Yes		If the North sea was made artificially warm would Newcastle have warm winters ?	Yes	
9.	Does the place get any rainfall ?	Yes				
10.	Is the water of North sea warm ?	No				

Formal Statement of theory.............

The gulf stream warm current carries a lot of heat from the topics towards North England. The heat of the current affects the sea breeze which blows on land and helps in keeping the cool winters of Silloth warm.

such questions which will help you to find everything about the objects, events, conditions and properties, of the problem.

Objects :

1. Was the strength of the current same in this experiment as well as the previous experiments ?
2. Were the electrodes made of copper ?

Events :

1. Was any chemical added to Sodium Chloride solution ?
2. Did any gas liberate at the anode ?

Conditions :

1. Does it take very long to collect Sodium from Sodium Chloride solution ?
2. Did the electricity stop after some time ?

Properties :

1. Does sodium react with the electrode during electrolysis ?
2. Did any gas evolve at the anode during electrolysis ?

PHASE III

DATA GATHERING : EXPERIMENTATION

(a) Generating opening moves to initiate the Third Phase of the Model.

Now you have gathered enough information and as a result you may have formed some hypothesis regarding the solution of the problem. Ask experimental questions to test the hypothesis.

(b) Data Gathering Experimentation Questions.

Objects :

1. If the Sodium Chloride is dissolved in any solvent other than water, will we get sodium ?
2. If we use Platinum electrodes in stead of copper electrodes will we get sodium ?

Events :

1. If I increase the concentration of Sodium Chloride solution and perform the experiment, will I get Sodium ?
2. If we do not use any solvent, can we get Sodium ?

Conditions :

1. If I pass the electric current, for a longer period of time will it help in forming Sodium ?
2. If I fill a test tube with water and invert it over the cathode for a long time, will I be able to collect some gas ?

Properties :

1. If I do the litmus test about ten or fifteen minutes after electrolysis will the litmus paper change colour ?
2. If I collect the gas that is evolved at the cathode and bring a burning match stick near the gas will there be any explosion ?

PHASE IV

FORMULATING AN EXPLANATION

(a) Generating opening moves to initiate the fourth phase of the Model.

How that you have tested your guess, I think you are in a position to formulate an explanation.

(b) Probable Theory

1. The degree of dissociation of Sodium Chloride in water may be very low as compared to that of other solutions of metal salts in water.

(c) Developing the theory.

(*i*) *Simple Linear Causation*

Sodium reacts with water.

(*ii*) *Theories of Properties*

The electronic configuration of sodium metal is such that when the sodium atom loses its outermost single electron, it reacts with water.

(*iii*) *Analogies* :

There are two friends 'A' (sodium) and 'B' (chlorine). 'A' is smart in his studies, financially well of and generous. He gives 'B' whatever he has in excess. A third boy 'C' (water) enters into the company of 'A' and 'B' and breaks their friendship. 'B' goes away leaving 'A' all alone. But somehow 'C' manages to get friendly with 'A' and starts getting all the help from 'A'.

(*iv*) *Application of Generalisation* :

Metals that require very low energy (Ionisation potential) to lose the outermost electron, react with water readily, (eg. Caesium, Rubidium, potassium, Sodium and Lithium).

PHASE V

ANALYSIS OF THE INQUIRY PROCEDURE

(a) Generating Opening Moves to Initiate the Fifth Phase of the model.

Let us review the steps of inquiry and analyses the Inquiry Procedure.

(b) Recapitulation of the Steps of Inquiry :

(i) Understanding the problem.
(ii) Asking fact finding questions.
(iii) Asking experimentation questions to test the hypothesis.
(iv) Formulating an explanation.

(c) Discussion of the Elements of Inquiry.

Why did you ask questions related to :

—strength of the current
—platinium electrodes
—increasing the concentration of the Sodium Chloride solution

TRANSCRIPT OF THE LESSON I

Name : Ms. Jessie Martis
Institution : Canossa High School
Subject : Chemistry

Date :
Class : X
Topic : A case of failure of electrolysis of a salt solution.

PHASE I

The Teacher explains the Inquiry Procedure.

T. Let us play a game called the Inquiry process. Everyone can participate in this game. I will present a puzzling situation You have to solve the puzzle by asking questions. You should frame the questions in such a way as to induce 'Yes' or 'No' answers from me. When you have gathered enough information, you should make assumptions regarding the solution and then ask questions to test these assumptions.

Encounter with the problem and episode analysis.

A laboratory assistant working for a Professor used to prepare the needed metals for the experiments by using the method of electrolysis. For example, when he needed Magnesium, he would prepare a solution of Magnesium Chloride in water and obtain Magnesium metal by performing electrolysis. In this way he used to obtain Silver from Nitrate, Copper from Copper Sulphate, etc. One day, the Professor was in need of some Sodium. The assistant tried to get Sodium from Sodium Chloride solution by the method of electrolysis. But, to his surprise, he could not get any Sodium metal.

T.	Can anyone tell me what is the discrepancy in this problem ?	The Teacher asks the students to account for the discrepancy.
S.	Electrolysis is used to obtain metals from the solutions of metal salts. However, when the laboratory assistant tried to obtain Sodium from Sodium Chloride solution by the method of electrolysis, the experiment failed. We have to find out why ?	
T.	Exactly. Now do you know what type of questions you have to ask ?	The Teacher reminds the inquiry process.
S.	'Yes', 'No' type.	
T.	Correct. If I cannot answer 'Yes' or 'No', I will be asking you to reframe them. If you ask more than one information in one question, I will ask you to be specific.	
S.	Was any current passed in the above experiment ?	PHASE II Data Gathering : Verification.
T.	Yes.	
S.	Was the current that was passed of same intensity in the above experiment as that in the previous experiments ?	
T.	Yes.	
S.	Were same type of electrodes used in all the experiments ?	
T.	Yes.	
S.	Was the concentration of all the solutions same ?	
T.	Yes.	
S.	Was the temperature of all the solutions same ?	
T.	Yes.	

S. Was any gas evolved at the anode during the electrolysis of Sodium Chloride solution ?

T. Yes.

S. Was direct current passed in the above experiment ?

T. Yes.

S. Was the experiment devised according to the conditions ?

T. Be specific.

S. Were both the electrodes dipped properly in Sodium Chloride solution ?

T. Yes.

S. Was the current passed for the same length of time as in other experiments ?

T. Yes.

S. Did the electrode react with Sodium ?

T. No.

S. Was some chemical added to Sodium Chloride Solution ?

T. No.

S. Did the experiment require more time as compared to other experiments ?

T. No.

S. Is there any difference in the property of Magnesium and Sodium ?

T. Yes.

S. Was the gas evolved at the anode Chlorine ?

T. Yes.

S. Did electrolysis take place in this experiment ?

T. Yes. Now who will summarise what we have gathered so far ?

The Teacher invites the students to summarise.

S. The current was of same intensity, the electrodes were of the same type, concentration was same, temperature was same, a gas was evolved at the cathode, direct current was passed, electrodes were dipped in the solution, current was passed for the same length of time, sodium did not have any reaction with the electrode, no chemical was added to Sodium Chloride solution, the experiment did not require more time, chlorine was evolved at the cathode.

PHASE III

Data Gathering: The teacher invities experimentation.

T. Now that you have gathered enough information, ask experimentation questions.

S. If you make Sodium Chloride more concentrated will you get sodium ?

T. No.

S. If we remove the batteries and use new ones can we get sodium ?

T. No.

S. If you change the electrodes will you get sodium ?

T. No.

S. If we take Sodium Carbonate solution instead of Sodium Chloride, solution, can we get sodium ?

T. No.

S. If we improve the technique of electrolysis can we get Sodium ?

T. Yes.

S. If we use Kerosene near the cathode instead of water can we get sodium ?

T. You seem to have some theory in your mind. Test it by asking more experimentation questions.

S. Was any gas evolved at the cathode ?

T. Yes. Now you may discuss with one another.

The teacher invites the students to interact with one another.

S. If I fill a test tube with water and invert it over the cathode for some time and collect this gas and test it with a burning splinter, will there be an explosion ?

T. Yes.

S. If I test the solution with red litmus paper about ten minutes after the electrolysis will it turn blue ?

T. Yes.

S. Does sodium react with water ?

T. Yes.

PHASE IV

Formulation of the principles. The teacher encourages the students to formulate the principle. The Teacher encourages the students to state theories of properties.

Now that you know the reason, can you formulate a theory or a principle.

S. Since Sodium metal formed at Cathode at once reacts with water, we cannot get Sodium.

T. Yes. Now can anyone tell me why Sodium reacts with water ? Who will tell me what you know about electronic configuration of sodium.

S. Sodium atom has one electron in its outermost orbit. It gives away that electron to water in order to attain stability and thus it reacts with water.

Analogies.

T. Now let us formulate an analogy from any subject or topic or from your daily life.

S. There are two friends 'A' (Sodium) and 'B' (Chlorine). 'A' is smart, financially well-off and generous. He gives 'B' whatever he has in excess. A third boy 'C' (water) enters into the company of 'A' and 'B' and breaks their friendship. 'B' goes away leaving 'A' all alone. 'C' somehow manages to get friendly with 'A' and starts getting all the help from 'A'.

T.	Now let us generalise the above theory. Metals that require very low energy (Ionisation Potential) to lose the outermost electron, react with water readily. e. g., Calcium, Rubidium, Potassium, Sodium, Lithium	Application of generalisation. Teacher states generalisation.
T.	Let us analyse the Inquiry Process. What type of questions did you ask first ?	PHASE V Analysis of Inquiry process.
S.	First we asked fact finding questions.	Teacher recapitulates the steps of Inquiry.
S.	Then we asked experimentation questions and we arrived at a hypothesis.	
T.	What type of hypothesis did you arrive at ?	
S.	The hydrogen gas is evolved at the cathode instead of the metal and the solution was alkaline to litmus.	
T.	How did the hypothesis help you ?	
S.	To formulate a theory.	
T.	And then what did we do ?	
S.	We studied why sodium reacts with water.	
T.	Yes. We call it a study of properties of the theory. After that what did we do ?	
S.	Application of generalisation.	
T.	Let us now turn our mind to a few questions asked by you. Will you tell me what theory you had in mind when you asked about the concentration of the solution.	Teacher discusses the elements of Inquiry.
S.	I thought if the solution is more concentrated, more sodium is deposited on the Cathode.	
T.	In fact if the dilution is more, the dissociation of ions is more i. e., more positive and negative ions are formed	

in the solution, hence more metal ions are deposited on the cathode.
Now who asked about the temperature of the solution ?
What made you ask that question ?

S. When the temperature of the solution is more the dissociation of the ions is more and hence more metal ions should be deposited on the cathode.

T. Yes, Your reasoning is perfectly right.

LESSON PLAN FORMAT (LPF) FOR ITM

Name : Ms. Jessie Martis
Institution : Canossa High School
Subject : 2
Lesson No. 2

Date : 28-7-86
Class : X
Topic : Buoyancy of water.

Educational (Behavioural) Objectives

1. To develop skill in asking verification questions.
2. To develop scientific thinking.

PHASE I

Explanation of Inquiry Procedure and Encounter with the Problem

(a) Generating opening moves to initiate the first phase of the Model :

Let us play a game called the Inquiry Process. All of you can take part in this game. I will present a puzzle in Science. You have to solve this puzzle by asking questions.

(b) Explanation of the Inquiry Procedure :

First I will present the problem. Then you will start asking questions to gather more information about the problem. You should frame questions in such a way that I can answer it by saying 'Yes' or 'No'. After you have gathered enough information you should make assumptions regarding the solution of the problem and then ask more questions to test whether your

WORK-SHEET (ITM)

Medium : English

Name of the Pupil : Rajani N.

Roll No. 23 Class

Date :

Institution : Canossa High School

Topic : A Case of Failure of Electrolysis of a Salt Solution.

Name of the teacher : — M/s Jessie Martis

Sr. No.	*Data Gathering Verification Questions*	*Teacher's Response*	*Sr. No.*	*Data Gathering Experimentation Questions*	*Teacher's Response*	*Theory and Reason*
1.	Was any current passed ?	Yes	1.	If you make Sodium Chloride Solution more concentrated will you get Sodium ?	No	
2.	Was the intensity of electricity same ?	Yes	2.	If you change the electrodes will you get Sodium ?	No	
3.	Was the concentration of all the solutions same ?	Yes	3.	If you take Sodium Carbonate Solution instead of Sodium Chloride Solution will you get Sodium ?	No	Sodium is collected at the cathode. But since it reacts with water as soon as it is formed, we cannot get Sodium metal.
4.	Was the temperature of all the solutions same ?	Yes	4.	If you improve the technique of electrolysis will you get Sodium ?	Yes	
5.	Did you pass A.C. current in Sodium Chloride solution ?	No	5.	Does Sodium react with water ?	Yes	
6.	Did the electrode react with Sodium ?	No				

Formal Statement of theory : The electronic configuration of Sodium is such that it has one electron in its outermost orbit. When it gives this electron to water it reacts with water.

assumptions are correct and try to get the solution to the problem.

(c) Encounter with the problem : Discrepant Event

I took water in two containers. When I put an object in the first container is sank. But when I put the same object in the second container is floated.

(d) Discrepancy Accounted For :

The object sank in water in one container but floated in water in the other container. Why ?

PHASE II

Data Gathering ; Verification :

(a) Generating Opening Moves to Initiate the Second Phase of the Model.

Now you may ask questions which can be answered by me in 'yes' or 'no'. Ask such questions which will help you to find everything about the object, events, conditions and properties of the problem.

Objects :

1. Did the two containers carry same amount of water ?
2. Was the object spherical in shape ?

Events :

1. Were the two containers kept on the same table ?
2. Did you add any salt to water in one of the containers ?

Properties :

1. Was the object made of metal ?
2. Was the object hollow in shape ?

Conditions :

1. Did you tie the object with a string to some support while placing it in the second container ?
2. Did you coat the object with any material before placing it in the second container ?

PHASE III

Data Gathering ; Experimentation

(a) Generating opening moves to initiate the third phase of the Model :

By now you have gathered enough information and as a result you may have formed some hypothesis regarding the solution of the problem. Now you may ask experimental questions to test your hypothesis.

(b) Data gathering experimentation questions :

Objects :

1. If the object was very thick would it float ?
2. If the object was very thin would it sink ?

Events :

1. If I place the larger area of the object on the surface of water, will it sink ?
2. If I place the narrow edge of the object on the surface of water will it sink ?

Properties :

1. If I add glycerine to the water in the beaker, will the object sink ?
2. If I heat water and then place the object in hot water will it float ?

Conditions :

1. If I flatten the object before placing in water will it float ?
2. After the object floats, if you wait for 10 to 15 minutes will it still float ?

PHASE IV

Formulating an Explanation

(a) Generating Opening Moves to Initiate the Fourth Phase of the Model

Now that you have tested your hypothesis I think you are able to formulate an explanation,

(b) Probable Theories :

1. If the density of the object is more than that of water the object sinks. And if the density of the object is equal or less than that of water the objects floats.
2. Water exerts upward force on the object.
3. The pressure exerted by the object is inversely proportional to the area of the base of the object.

(c) Developing the Theory :

(i) Simple Linear Causation :

When an object is immersed in water wholly or partly it displaces some water. This displaced water exerts an upward force (known as upthrust) on the object. If this upthrust is equal to the weight of the object, the object floats and if it is less than the weight of the object. the object sinks.

(ii) Theories of Properties :

The upthrust of water is the weight of water displaced by the immersed part of the body. If the surface area of the object touching the water is large, a large, volume of water is displaced and in turn the upthrust of water is also large, hence the body floats and vice versa.

(iii) Analogies :

1. A solid piece of iron sinks in water but a ship made of iron floats on water.
2. A paper dropped from the terrace of a building floats in air but when it is crushed into a lump and then dropped it falls on the ground. Here the upthrust of air acting on the paper surface, is large hence it floats in air. But the upthrust of air acting on the paper that is crushed into a lump is small, hence it sinks in air and falls on the ground.

(iv) Application of Generalisation :

When a body is immersed in a liquid wholly or partly it loses some weight. This loss of weight is equal to the weight of the liquid displaced by the immersed part of the body. In the case of a floating body when it is placed on a liquid only a portion of it is immersed in the liquid. The weight of the liquid displaced by the immersed part is equal to the weight of the body.

PHASE V

Analysis of the Inquiry Procedure :

(a) **Generating Opening Moves to Initiate the Fifth Phase of the Model :**

Let us review the steps of inquiry and analyse the Inquiry Procedure.

(b) **Recapitulation of the steps of Inquiry :**

(i) Understanding the problem.
(ii) Asking fact-finding questions.
(iii) Asking experimentation questions to test the hypothesis.
(iv) Formulating an explanation.

(e) **Discussion of Elements of Inquiry :**

Let us discuss why some of you asked questions like—

(i) Did you add any salt to water ?
(ii) Did you coat the object with any material ?
(iii) If the object was very thick would it float ?
(iv) If the object was very thin would it sink ?
(v) After the object floats if you wait for sometime will it still float ?

TRANSCRIPT OF THE LESSON 2

Name : Ms. Jessie Martis
Date : 28-7-86
Institution : Canossa High School
Class : X
Subject : Physics
Topic : Buoyance of Water
Lesson 2

PHASE I
The Teacher explains the Inquiry Procedure.

T. Let us play a game called the Inquiry Process. Everyone can participate in this game. I am going to present a puzzling situation. You have to solve the puzzle by asking questions. You should frame questions in such a way that I can answer them by' Yes' or 'No'. If you ask more than one information in a question, I shall be asking you to be specific. If I cannot answer 'Yes' or 'No', I shall be asking you to reframe them.

Encounter with problem and episode analysis.

Now, here is the puzzle, I took water in two containers. When I put an object in the first container it sank, but when I put the same object in the second container it floated.

The teacher asks the students to account for the discrepancy.

T. Can anyone tell me what is the discrepancy in this problem ?

S. The same object sank in the water of one container but floated in the water in the second container.

PHASE II

Data Gathering (Verification).

T. Correct. Now you may start asking questions in order to gather information.

S. Did you take ice in the second container ?

T. No.

S. Was the amount of water in the two containers same ?

T. Yes.

S. Were the two containers of the same size ?

T. Yes.

S. Were the containers of same shape ?

T. Yes.

S. Did you add any salt in one container ?

T. No.

S. Did you support the object that floated with the help of a string ?

T. No.

S. Did you add oil to one container ?

T. No.

S. Did you coat the object with wax, before placing is second container ?

T. No.

S. Did you coat the object that floated with any material ?

T. No.

S. Was the object made of metal ?

T. Yes.

S. Were the two containers kept on the same table ?

T. Yes.

S. Was the object hollow in shape ?

T. No.

S. Was the object rectangular in shape ?

T. Yes. Now will you summarise what we have gathered so far ?

S. The amount of water in both the containers was the same. The size and shape of the containers was same.

S. You did not add salt nor oil in any of the containers.

S. You did not hang the object to any support.

S. No coating was given to the object that floated.

S. The object was made of metal, it was not spherical nor hollow. It was rectangular in shaps.

S. Both the containers were kept on the same table.

T. Now that you have gathered enough information you must be having some assumptions in your mind. Ask experimentation questions to test whether your assumptions are correct.

PHASE III

Data Gathering. The Teacher invites experimentation.

S. If I add glycerine to the water in the first container will the object sink ?

T. Yes.

S. If I heat the water in the second container and then place the object in hot water will it float ?

T. Yes.

S. If I crush the object and then place in the water in second container will it float ?

T. No.

S. If the object was very thick would it float ?

T. No.

S. If the object was very thin would it float ?

T. Yes.

S. If I place the larger area of the object on the surface of water in the first container will it sink ?

T. No.

S. If I place the narrow edge of the object on the surface of water will it sink ?

T. Yes. Now you may discuss with one another to find out the correct theory.

S. Does it have to do anything with the surface of the object touching water ?

The teacher invites the students to interact with one another.

T. Yes.

S. Does water also have something to do so that the object may sink or float ?

T. Yes. Now you seem to have a correct theory in your mind. Can anyone state your theory ?

S. When a body is placed on water the water exerts an upward force on the body.

T. Yes and this upward force is called the

PHASE IV

Formulation of Principles. The Teacher encourages the students to formulate the principle.

	upthrust of water. Now can you State how does this upthrust help a body to sink or to float ?	The teacher helps the students to lead to the simple Linear causation of the theory.
S.	When an object is immersed in water wholly or partly it displaces some water. This displaced water exerts an upthrust on the object. If this upthrust is equal to the weight of the object, than the object floats and if it is less then the object sinks.	
T.	Good. Now can you tell me how the surface area of the object in contact with water, helps the object sink or float ?	The teacher helps the students to State theories of properties.
S.	When the surface area of the object in contact with water is large then the volume of water displaced is also large and the upthrust exerted by water on the object is large. Hence the body floats.	
T.	You are right. Now will anyone give an analogy from any subject ?	Analogies.
S.	A metal foil floats on water but when it is crushed into a lump and then placed on water it sinks.	
S.	A solid piece of iron sinks in water but a ship made of iron floats on water.	
T.	Now let us learn the correct application of generalisation of the above theory.	Application of generalisation.
T.	When a body is immersed in a liquid wholly or partly it loses some weight. This loss of weight is equal to the weight of the liquid displaced by the immersed part of the body. In the case of a floating body when it is placed on a liquid only a portion of it	The teacher states the application of generalisation.

is immersed in the liquid. The weight of the liquid displaced by the immersed part is equal to the weight of the body. Therefore it loses all its weight.

T. Let us now analyse the Inquiry Process. What type of questions did you ask first ?

PHASE V
Analysis of Inquiry Process. The teacher recapitulates the steps of Inquiry.

S. First we asked fact finding questions.

S. Then we asked experimentation questions and we arrived at a hypothesis.

T. What type of hypothesis did you arrive at ?

S. The water exerts an upward force on the object. Also the surface in contact with water was the cause for it to sink or float.

T. How did you confirm whether your hypothesis was correct ?

S. When we asked If the object was very thick would it float ? your answer was 'No'. So we concluded that only when the object is thin and the surface area is large it floats on water.

T. Why did you ask the question 'Did you add any salt to the water ?

Teacher discusses the elements of Inquiry.

S. Salt increases the density of water. So I thought that the object floated because the water was denser than the object.

T. Why did you ask whether the object was coated with wax ?

S. Wax is less dense as compared to metals. So I thought when it is coated with wax it may float on water.

T. Why did you ask "If the object was very thin would it sink ?"

WORK-SHEET (ITM)

Name of the pupil : Vijaya P. L.
Institution : Canossa High School

Roll No. 43 Class X
Topic Buoyancy of Water

Medium : English
Date :
Subject : Physics
Name of the teacher :—
Ms Jessie Martis

Sr. No.	*Data Gathering Verification Questions*	*Teacher's Response*	*Sr. No.*	*Data Gathering Experimentation Questions*	*Teacher's Response*	*Theory and Reason*
1.	Did you take ice in one container ?	No	1.	If I add glycerine to the first container will the object sink ?	Yes	
2.	Was the amount of water in the two containers same ?	Yes	2.	If I heat the water in the second container and then place the object in hot water will it float ?	Yes	
3.	Were the containers of the same shape ?	Yes	3.	If I crush the object and then place in the water in second contanier will it float ?	No	Upward force of water supports the object.
4.	Did you add any Salt in one container ?	No	4.	If the object was very thick would it float ?	No	
5.	Did you support the object that floated with the help of a string ?	No	5.	If the object was very thin would it sink ?	No	

(Contd.)

Sr No.	*Data Gathering Verification Question*	*Teacher's Response*	*Sr. No.*	*Data Gathering Experimentation Questions*	*Teacher's Response*	*Theory and Reason*
6.	Did you add oil in our container ?	No	6.	If the object was very thin would it float ?	Yes	The larger area of the surface of the object in contact with water helps it float.
7.	Did you coat the object with wax ?	No	7.	If I place the larger area of the object on water would it sink ?	No	
8.	Was the object made of metal ?	Yes				

When an object is placed on a liquid, it displaces some water. This displaced with water exerts an up thrust on the object. If this upthrist is equal to the weight of the object, then the object floats and if it is less than the weight of the object then the body sink.

S. If the object is thin and yet sinks then it is surely the manner with which it is placed on water makes it sink or in other words it is the area in contact with water that makes it sink.

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ABOUT THE BOOK

The practice of training programme in teacher education is generally arranged on Herbartian methods of teaching and the trainees are generally trained through the Wholistic Approach. A number of research studies were organised to see the effectiveness and adaptability of microteaching. However, the question of integration of skills was a crucial bottle against the speedy development of new Models of Teaching.

D19

In this process the work of Bruce Joyce and weil Marsha has proved immensely useful. Therefore, a large number of orientation and research seminars have been conducted on Models of Teaching in different parts of the country. Need for adequate instructional material has been felt for the effective use of these models. In the massive teacher education programme of the New Education Policy, the Inquiry Training Model has been identified as an important component. Keeping these points in mind, a group of researchers have made a joint effort to prepare the present model. This team of researchers has made rich contributions by synthesising the findings of various research studies and the practical experience gained at various seminars and workshops on models of teaching.

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